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ENDOLYMPHATIC AND ASSOCIATED DUCTS IN MAN

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HISTORICAL REVIEW

Although numerous studies have dealt painstakingly with the nervous portions of the membranous labyrinth, few have been concerned with the structure of the non-nervous areas of the epithelial ducts. Consequently, little was known until recently about the endolymphatic duct in man. Two portions of the duct system have of late received attention, namely, the slitlike communication of the endolymphatic duct with the utricle and the rugose wall of the endolymphatic duct itself.

In 1928 Bast [1] first described the "cusp or valve" which in the human embryo "projects into the utriculus and guards the utricular opening into the utriculo-endolymphatic duct." Struck by its definiteness, Bast expressed the belief that so pronounced a structure must serve a function and suggested that "in case of any sudden pressure disturbance this valve may prevent the outflow of endolymph from the utricle, thus maintaining a more constant pressure within the utricle and semicircular canals." Bast later [2] found evidence of its function in two cases of ruptured saccule, and on the basis of the observation that the cochlear duct and saccule may be disturbed to the extent of collapse without damage or collapse of the utricle and semicircular ducts, he concluded that the utriculo-endolymphatic valve is responsible for the maintenance

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Read at the annual meeting of the American Association of Anatomists, Philadelphia, March 30, 1934 (abstr., Anat. Rec. **58**:30, 1934).

Contribution 232 from the Anatomical Laboratory of the Northwestern University Medical School. An investigation conducted under the auspices of the Central Bureau of Research of the American Otological Society.

1. Bast, T. H.: The Utriculo-Endolymphatic Valve, Anat. Rec. **40**:61-65,

2. Bast, T. H.: Function of the Utriculo-Endolymphatic Valve: Two Cases of Ruptured Saccule in Children, Arch. Otolaryng. **19**:537-550 (May) 1934.

of normal pressure in the utricle and semicircular ducts when the pressure in the saccule and cochlear duct is suddenly reduced.

Wilson and Anson [3] described the fold or valve as it appeared in the 2 year old child and in eleven adults, but as a possible objection to Bast's functional interpretation these authors pointed out that the valve is seemingly a much stouter structure than the epithelial vesicle against which it lies; therefore, in case of disturbance in pressure there would be no substantial wall to complete the valvular mechanism, unless it were assumed that the perilymph, likewise affected, served as a liquid support for the thin-walled utricle. The comparative study of Hoffman and Bast [4] on ten species of mammals established the regular presence of the valvelike fold. Roberts [5] observed the fold to be uniformly present and constant in shape in sixty ears obtained from a single species of mammal, the albino rat; he too considered the fold to be "a constant and definite structure" of the membranous labyrinth. Anson [6] followed its development in representatives of twelve species of mammals, in a study of over 200 series in the Harvard embryologic collection.

These several investigations demonstrated that the offshoot of the endolymphatic duct to the utricle is not a simple quill-like tube (figs. 5 and 6) but a communication flattened by a valvular element into an elongate crevice (figs. 9, 10 and 11).

The investigations of Guild [7] were concerned with the structure of the endolymphatic duct rather than with the form of its utricular communication. They showed convincingly that the endolymphatic duct in the guinea-pig and in man [8] differs strikingly in shape from the conventional pictures of this part; his studies dealt also with the exact histologic nature and the function of the rugosities described and figured

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3. Wilson, J. G., and Anson, B. J.: The "Utriculo-Endolymphatic Valve" (Bast) in a Two-Year-Old Child, Anat. Rec. **43**:145-153, 1929. Anson, B. J., and Wilson, J. G.: The Utricular Fold in the Adult Human Ear, ibid. **43**:251-254, 1929.

4. Hoffman, E. F., and Bast, T. H.: A Comparative Study of the "Utriculo-Endolymphatic Valve" in Some Common Mammals, Anat. Rec. **46**:333-347, 1930.

5. Roberts, J. T.: On the Utriculo-Endolymphatic Valve in the Albino Rat, Anat. Rec. **53**:255-264, 1932.

6. Anson, B. J.: The Early Development of the Membranous Labyrinth in Mammalian Embryos, with Special Reference to the Endolymphatic Duct and Utriculo-Endolymphatic Duct, Anat. Rec. **59**:15-25, 1934.

7. Guild, S. R.: (*a*) Observations upon the Structure and Normal Contents of the Ductus and Saccus Endolymphaticus in the Guinea-Pig (Cavia Cobaya), Am. J. Anat. **39**:1-56, 1927; (*b*) The Circulation of the Endolymph, ibid. **39**:57-81, 1927.

8. Guild, S. R.: Paper read at the annual meeting of the American Association of Anatomists in Ann Arbor, Mich., April 5-7, 1928 (abstr., Anat. Rec. **38**: 12, 1928).

earlier by Boettcher [9] (1869) and Sterzi [10] (1910). While the duct is usually and erroneously shown as a simple tube, possessing merely a dilated terminal saccus (figs. 5 and 6), it is actually a complex channel, with regionally specialized areas (fig. 8)—a specialization which affects not only the conformation of the walls but the constituent epithelial cells. The epithelial layer as a whole is depressed into crypts and elevated into projections resembling villi, most of which are vascularized. In support of his belief that the morphologic features of the endolymphatic duct and sac in the guinea-pig possess functional significance, Guild presented experimental evidence of definite circulation of the endolymph toward the rugose distal portion of the endolymphatic duct, through the epithelial wall and thence into the small vessels of the subepithelial connective tissue.

Our present study is likewise concerned with the utricular and the endolymphatic duct in man, and particularly with the morphologic features of the ducts which can be studied advantageously with the aid of wax plate reconstructions.

MATERIAL AND METHODS

The series reported on in this paper are contained in the otologic collection at the Northwestern University Medical School and were made available by Dr. J. Gordon Wilson. The specimens were fixed in a dilute solution of formaldehyde U.S.P. (1:10) and decalcified in 3 per cent nitric acid in a solution of formaldehyde of the strength just given; they were embedded in pyroxylin and sectioned in the horizontal plane (fig. 4) at a thickness of 14, 20 or 35 microns, and the sections were stained with either the hematoxylin and eosin or the Van Gieson stain. All the series were prepared by Miss Helen Banks.

In a series of sections obtained from a 3 year old child the space enclosed by the communication between the utricle and the endolymphatic duct was reconstructed in wax by the Born method; in this series and in a series from an adult the middle section of the endolymphatic duct was similarly reconstructed. The reconstruction of the utriculo-endolymphatic communication (fig. 23) of the child included an area of twenty-nine sections and was prepared with a magnification of 200 diameters; the reconstruction of the middle third of the endolymphatic duct in the same series (figs. 26 and 27) was made from fifty-four sections, with a magnification of 400 diameters, and the reconstruction of the middle third of the endolymphatic duct of an adult (figs. 28 and 29), from thirty-six sections, with a magnification of 300 diameters. The photomicrographs (figs. 24 and 25) were taken with a magnification of 170 diameters to show the important histologic features of the enclosing walls. Figures 12 to 22 were traced with an Edinger projection apparatus at a magnification of 240 diameters, and figures 1 to 3, at a

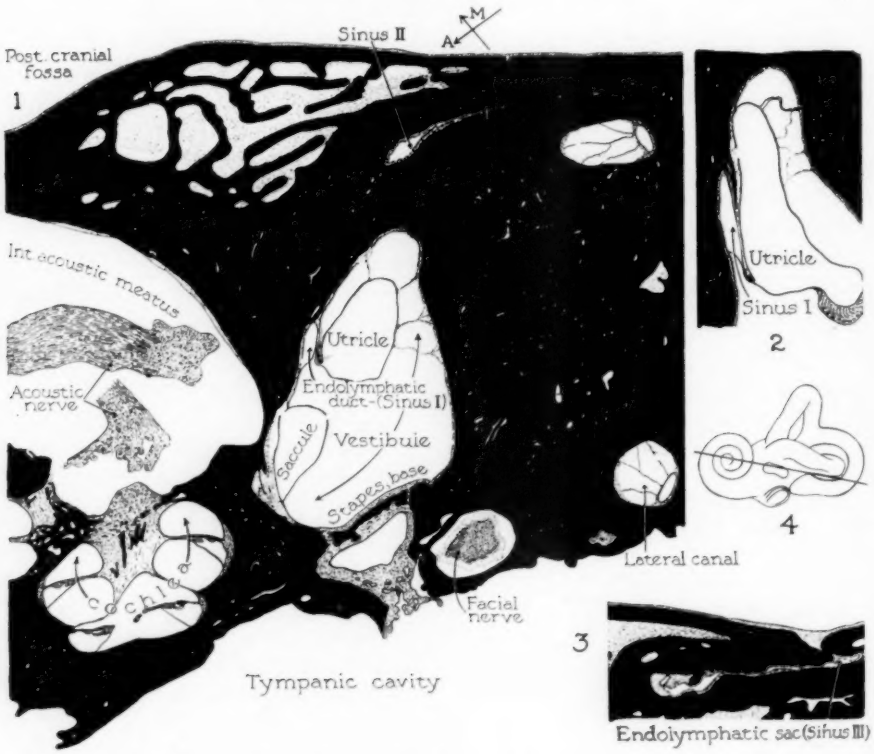
9. Boettcher, A.: Ueber Entwickelung und Bau des Gehörlabyrinths nach Untersuchungen an Säugethieren, Verhandl. d. K. Leop. Carol. deutsche Akad. d. Naturf. **35**:1-203, 1869; Ueber den Aquaeductus vestibuli bei Katzen und Menschen, Arch. f. Anat., Physiol. u. wissensch. Med., 1869, pp. 372-380.

10. Sterzi, G.: Il sacco endolinfatico: Ricerche anatomiche ed embriologiche, Morphol. Jahrb. **39**:446-496, 1910.

magnification of 18 diameters. Between the sections represented by figures 12 and 13, twenty-nine sections intervened; between those represented by figures 13 and 14, nine sections, and between those represented by figures 14 and 15, sixty sections.

OBSERVATIONS

Proximal Portion of the Endolymphatic Duct.—In horizontal serial sections through the petrous part of the temporal bone, there was



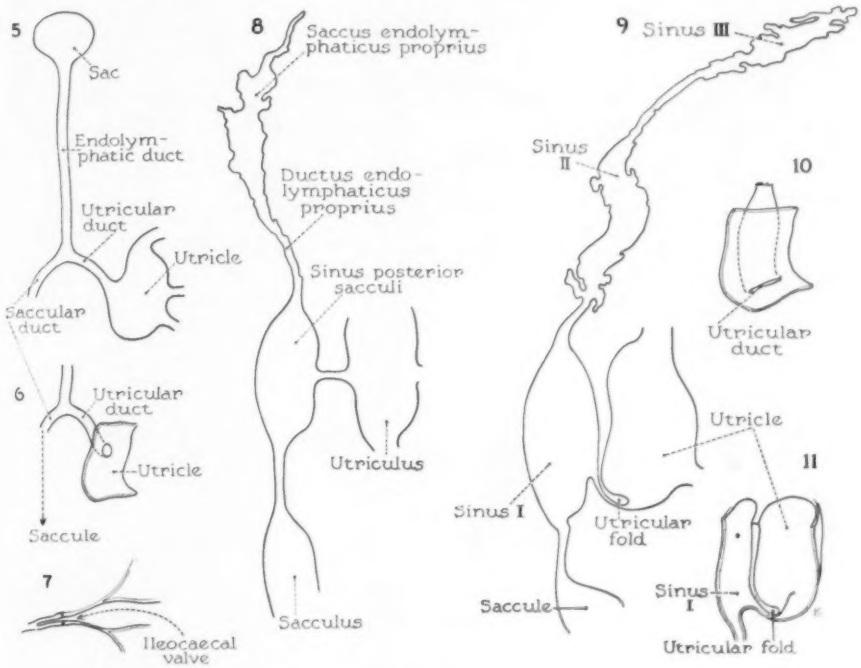
Figs. 1-4.—Figures 1 to 3 are drawings of sections through the temporal bone of a child 3 years of age; magnification, 7 diameters. The sections shown in figures 1 and 2 were taken at the level of the utricular fold and the proximal endolymphatic sinus (*sinus I*); figure 1 also represents within the vestibular aqueduct the intermediate sinus (*sinus II*). The arrow *M* is directed medially, the arrow *A*, anteriorly. Figure 3, with which figure 15 should be compared, shows a section through the endolymphatic sac (*sinus III*) at the cranial aperture of the vestibular aqueduct.

In figure 4 the line indicates the plane of section for this series and the approximate level of the section shown in figure 1.

observed on the medial wall of the osseous vestibule a large dilatation of the endolymphatic duct separated from the more capacious utricle by a fold or valve (figs. 1 and 2). In general the wall of the sinus-like

dilatation was smooth, but in some series it was irregular distally, forecasting the marked complexity of the portion of the duct with which it becomes continuous posteriorly. Anteriorly the sinus joined the saccule through the narrow saccular (or sacculo-endolymphatic) duct.

The epithelium of the sinus was of cuboid type. On the medial wall it lay on a thin, nonvascular layer of connective tissue; its lateral wall was one layer of the utricular fold, around the free tip of which this layer was continuous with the epithelium of the utricle. The two layers enclosed wide-meshed connective tissue of areolar type, in which

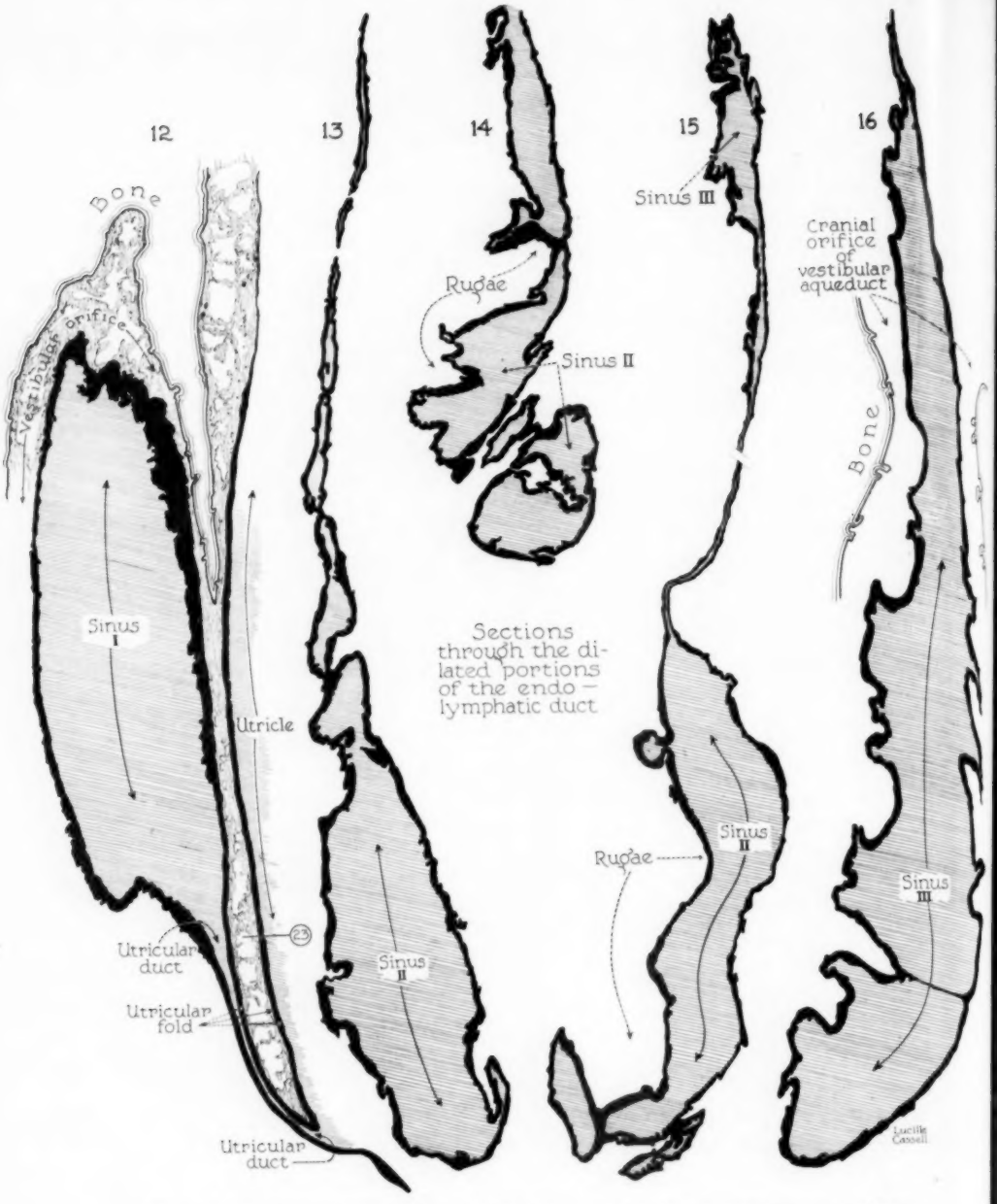


Figs. 5-11.—Figures 5 to 8 illustrate diagrammatically the morphologic features of the endolymphatic and associated ducts.

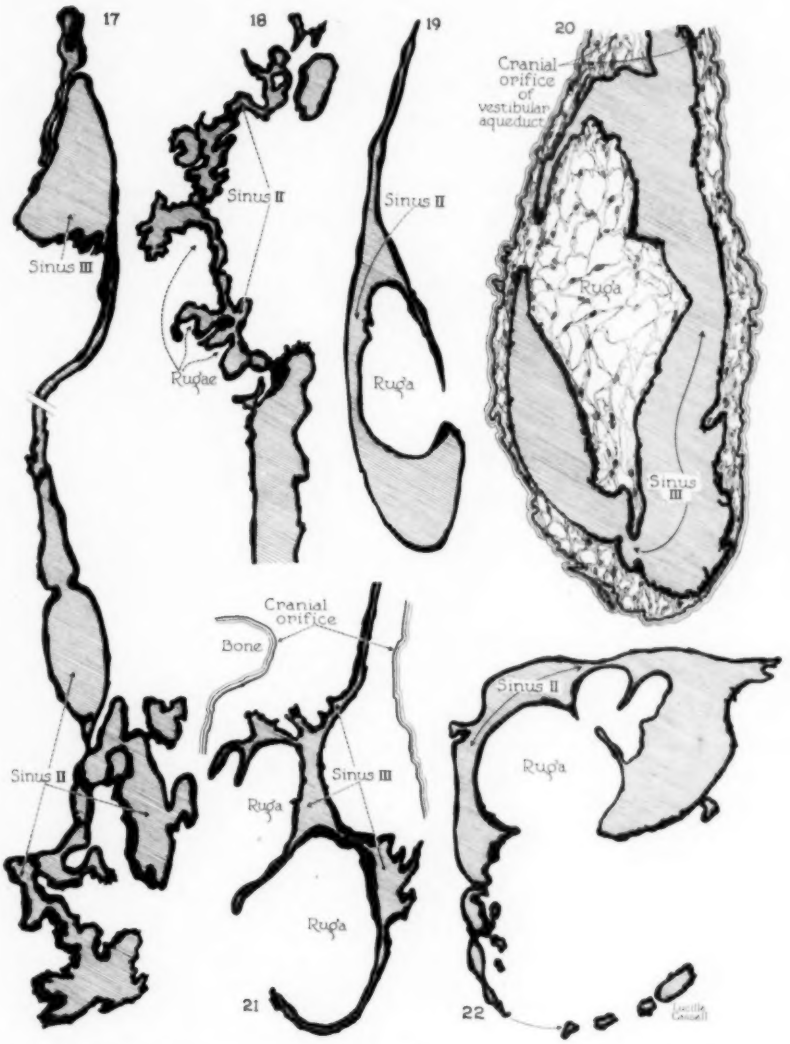
In figures 5 and 6 the conventional diagrams are shown; in figure 7 the ileocecal valve, to which the utriculo-endolymphatic valve (utricular fold) is likened, is illustrated; in figure 8 the interpretation of Guild, with the terminology he proposed, and in figures 9, 10 and 11 our conception, with the terms we proposed.

coursed small blood vessels. Into the attached or basal part of the fold a bony ledge extended for a distance of one-fourth the total length of the fold, its periosteum merging finally with the stroma of the fold (figs. 2 and 12).

As seen in the sections, the fold formed a shank which ended in a free extremity (fig. 12). This extremity turned laterally into the utricular space, describing as it did an even curve, more marked toward the



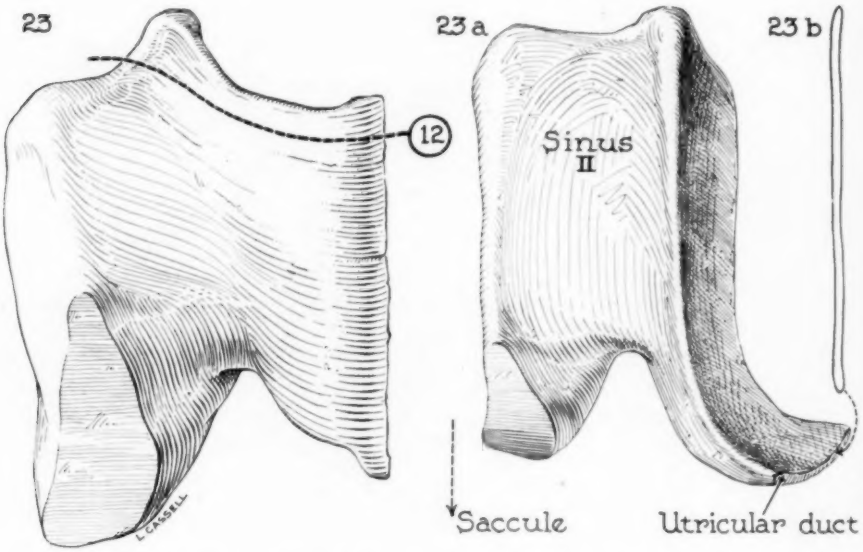
Figs. 12-16.—Drawings (with the Edinger projection apparatus; magnification, 48 diameters) of the endolymphatic duct, from serial sections of the temporal bone. Figures 12 to 15, with which figures 1 to 4 should be compared, represent the duct in a child 3 years old, and figure 16, the duct in a full term fetus. Figure 12 indicates a level through the proximal dilatation *(sinus I)* as it enters the vestibular orifice of the vestibular aqueduct, the utricle and the communication between these structures beneath the utricular fold; the encircled *23* indicates the distal limit of the reconstruction shown in the figure of that number. Figures 13 and 14 show sections through the intermediate dilatation *(sinus II)* and the succeeding constriction; the rugose area in figure 14 is represented in the photomicrograph in figure 24, and the levels at which the sections were taken are indicated in figures *26* and *27*. Figure 15 shows the intermediate and the distal dilatation, the latter *(sinus III)* being the endolymphatic sac (figure 3 should be compared); approximately one third of the constricted portion between the areas indicated by *sinus II* and *sinus III* has been omitted. Figure 16 shows the distal dilatation in relation to the cranial orifice of the vestibular aqueduct (dura mater not shown).



Figs. 17-22.—Drawings (magnification, 48 diameters) of the endolymphatic duct from serial sections. Figures 17 and 18 show the intermediate and the distal dilatation in an adult (age unrecorded); in figure 17 a short segment of the constricted portion has been omitted. These sections are beyond the area included by the reconstructions shown in figures 28 and 29. Figure 19 shows the intermediate dilatation in an adult (aged 18), and figure 20, the distal dilatation near the cranial orifice of the aqueduct in an infant (aged 6 weeks); the latter represents not only the epithelium of the duct but the osseous wall of the vestibular aqueduct and the intervening vascular stroma (omitted in the other drawings). Figure 21 shows the distal dilatation in another infant (3 months), with the tall rugosities and the narrowed lumen of the duct at the cranial orifice (dura mater not shown). Figure 22 shows the intermediate dilatation in an adult of 57.

termination and bounding a narrow space—the utricular (or utriculo-endolymphatic) duct. In our series from the 3 year old child the pedal portion existed as a free flap in thirteen successive sections, each 20 microns in thickness, and in eight additional sections the foot appeared as a low ledge on the utricular wall.

In a reconstruction of the utricular duct and the adjacent portions of the epithelial vesicles with which it communicates, the form of the duct was evident (figs. 23 and 23*a*); it was deep in a craniocaudal direction but narrow mediolaterally; in our reconstruction the first dimension measured forty times the second. If the duct were cut across it would have the form of a greatly flattened ellipse (fig. 23*b*).



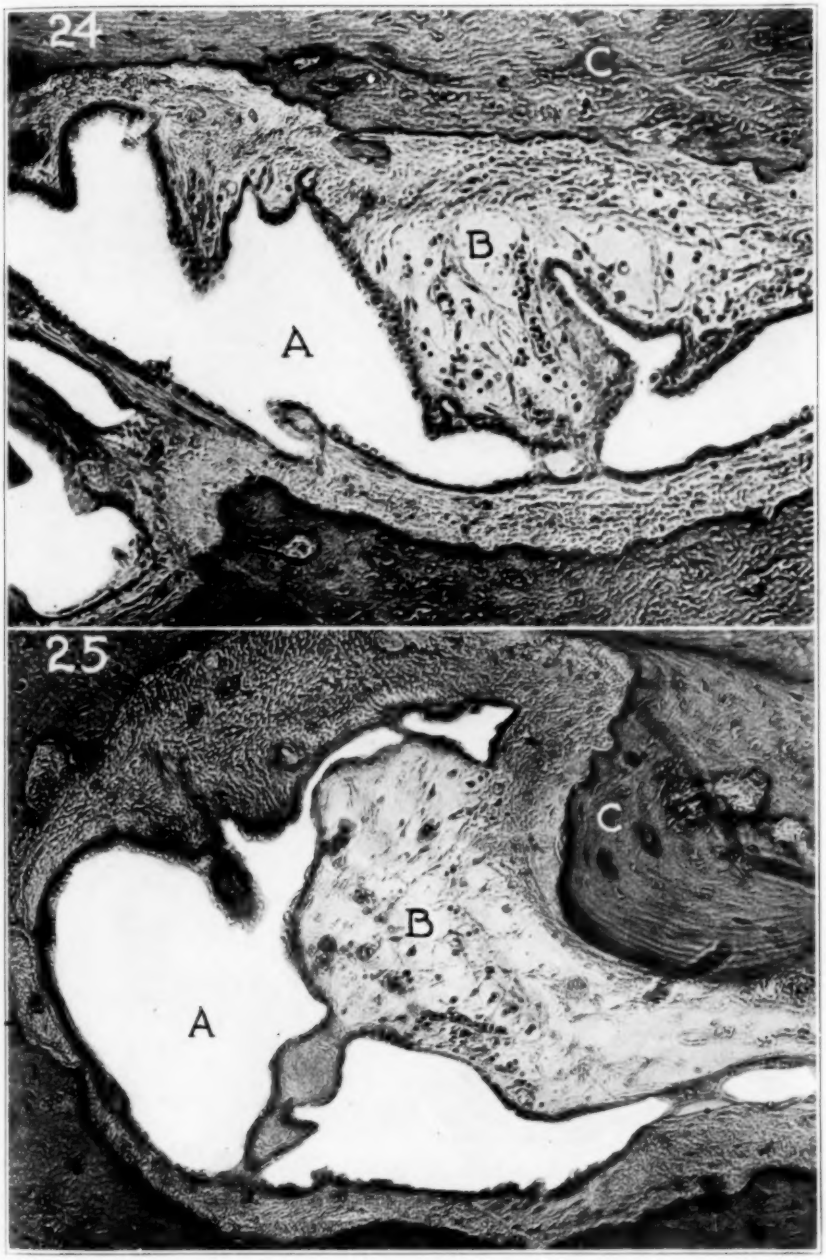
Figs. 23-23*b*.—Figures 23 and 23*a* are drawings (magnification, 100 diameters) of a reconstruction representing the space enclosed by the utricular duct and the adjoining portion (*sinus I*) of the endolymphatic duct in a child of 3 years.

Figure 23 shows the anterolateral aspect; the cut at the reader's right marks the line of junction of the utricle and the utricular duct at the free end of the utricular fold. The dotted line indicates the level of the section shown in figure 12.

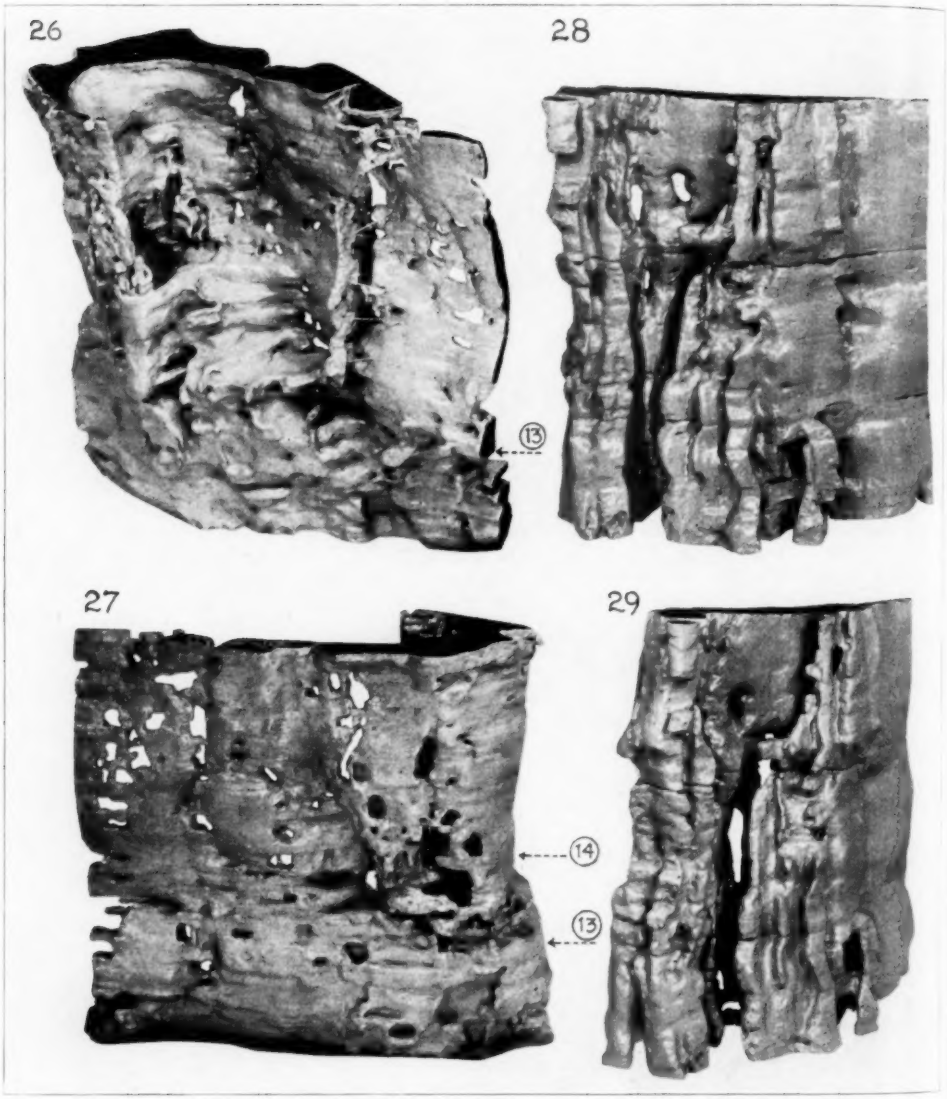
Fig. 23*a* shows the superior aspect of the same reconstruction. The direction in which the saccule lies is indicated by the arrow.

Fig. 23*b* is an outline of the lumen of the utricular duct at its point of continuity with the utricle.

As the sinus-like enlargement of the duct extended distally it became continuous with a constricted portion of the duct, and its walls were thrown into villous irregularities (fig. 12); a second and considerable widening was next encountered, the walls of which, becoming exceedingly furrowed, encroached on the lumen (the lower portions of figures



Figs. 24-25.—Photomicrographs (magnification, 170 diameters) of sections of the ear of the child 3 years of age, taken through the intermediate dilatation *(sinus II)* of the endolymphatic duct; the section photographed in figure 24 is represented in the drawing in figure 14. The wide irregular lumen *(A)* invaded by rugosities, the subjacent vascular connective tissue *(B)* and the bony wall *(C)* of the vestibular aqueduct are represented. The level of the section shown in figures 14 and 24 is indicated in the reconstruction reproduced in figure 27.



Figs. 26-29.—Figures 26 and 27 are photographs (magnification, 55 diameters) of the lateral and medial aspects, respectively, of a reconstruction of the lumen of the middle third of the endolymphatic duct in the child 3 years old. The levels of the sections drawn in figures 13 and 14 are indicated. The depressions represent rugosities of the epithelial wall, the fenestrations, points at which the opposing walls are in contact.

Figures 28 and 29 are photographs (magnification, 40 diameters) of the medial and anteromedial aspects, respectively, of a reconstruction representing the space of a similar area in an adult.

13 and 14); a markedly constricted portion followed, the walls of which were plain (the upper part of figure 13 and the middle part of figure 15); another expansion—the third in order—was finally encountered (fig. 3 and the upper part of figure 15); this terminal dilatation, conventionally termed the saccus endolymphaticus, exhibited once more a rather elaborate system of elevations; it was situated near or at the cranial orifice of the vestibular aqueduct. It is with the form and structure of the last two expanded subdivisions of the duct that the succeeding part of our description will be concerned.

Intermediate Portion of the Endolymphatic Duct.—The complex arrangement of projections in the dilated intermediate portion of the endolymphatic duct was a striking feature of the sections. The epithelium extended deep into the connective tissue at one point to form a crypt and projected like a villus into the lumen at another point. The projections were fundamentally similar in representatives of all age groups, whether in the fetus (fig. 16), infant (figs. 20 and 21), child (figs. 13 to 15), young adult (figs. 17, 18 and 19) or older adult (fig. 22). The projections frequently formed bridges across the lumen of the duct (figs. 16, 17, 24 and 25). The connective tissue underlying an epithelial elevation was sometimes eight times the thickness of the same layer supporting the opposite wall. Furthermore, the connective tissue of the projections was more vascular, and especially in the region of these elevations it was of delicate structure (figs. 20, 24 and 25). The numerous capillaries in the connective tissue were derived in part at least from the vessels of the haversian canals. In the large projections capillary vessels could be followed in their coursing from the base of the elevation toward the tip, an arrangement of the blood supply which resembled that seen within an intestinal villus. The proportion of dense connective tissue to areolar tissue was much higher in the adult than in the child, the areolar tissue in the adult being virtually limited to the core of the elevation.

In reconstructions of the space contained within the intermediate dilatation (sinus II) the full character of the elevations is shown effectively (figs. 26 to 29); by means of the reconstructions it was established that the individual villus-like projections seen in sections were parts of extensive longitudinal folds;[11] it was further demonstrated that what

11. Since the reconstructions are casts of spaces, the irregularly shaped excavations of the reconstructions represent hillocks of tissue in the sections which projected into the lumen of the duct; conversely, the ridges of the reconstruction represent crypts in the tissue where the lining epithelium extended downward into the supporting connective tissue layer. In other words, a depression in the reconstruction is really an evagination of tissue into the lumen, whereas a projection from the model is an invagination of the lining epithelium of the duct. The perforations in the reconstruction represent bridges of tissue which extended across the lumen (figs. 24 and 25).

appeared to be separate lacunar spaces of the duct when viewed in the sections were actually intercommunicating channels separated from one another locally by continuity of the opposing epithelial walls—that is, the disjunction of the larger spaces was limited to relatively few successive sections. The multiplicity of these fenestrations (representative of epithelial bridges across the lumen) is one of the most striking features of the model shown in figures 28 and 29. They are greater in number in the thinner parts of the model, and their size and shape are inconstant. In addition to these perforations there are numerous shallow depressions representing invasions of the lumen by projections of a lesser order, which did not reach to the opposing wall of the duct. The system of folds in the reconstruction for the adult is more striking than that in the reconstruction for the child, the elevations being higher and the depressions more like crevices (figs. 28 and 29); the fenestrations are larger, suggesting coalescence of earlier smaller ones.

Distal Portion of the Endolymphatic Duct.—The terminal portion of the endolymphatic duct would, in our succession, be the distal dilatation, or sinus III. The epithelium and the connective tissue were of a type similar to those of the intermediate portion of the duct, but blood vessels seemed to be less abundant in the region of the sac. In some specimens from the adult the system of folds was much less elaborate than that in the expanded intermediate portion of the duct.

COMMENT

Our observations show that the stylized figures of the endolymphatic and associated ducts available in textbooks are not only inadequate but misleading. From the utricular extremity to the dural end the duct is unlike that described in the conventional textbooks commonly utilized by the student and practitioner; it is not the reedlike undifferentiated tube (figs. 5 and 6) to the illustrations of which one has become accustomed.

The utricular duct is not circular in cross-section, nor is its utricular orifice round. Actually, at this proximal extremity the duct is greatly compressed into elliptic form (figs. 9, 10 and 23*b*), and its posterior wall is the curtain-like utriculo-endolymphatic fold or valve (figs. 2 and 12). In the series from the child and from the adult the valve was observed to possess the form which had been ascribed to it by Bast [1] in his account of the structure in a human fetus and by Anson and Wilson [3] in their studies of the ear of the child and of the adult. That the valve is not limited in its occurrence to man but is rather a regular

mammalian feature was later pointed out by Hoffman and Bast,[4] Roberts [5] and Anson [6] in comparative anatomic observations.[12]

Medial to the utriculus is the sinus-like dilatation of the endolymphatic duct, from which the utricular duct is a lateral extension (fig. 12); it was regularly present in the numerous series of human ears examined. In general its wall is smooth; occasionally in its distal portion the wall may become plicate, forecasting the more involved pattern of infoldings encountered in the succeeding part of the duct. It is more pronounced in man than in the guinea-pig, in which it was first described by Guild,[7a] and it may attain a size almost equal to that of the utricle but is more elongated.

Next beyond the sinus, in the distal direction, is situated a constricted section of the duct, in which the folds, first seen faintly in the sinus, continue as prominent creases. These need not be separately described, since comparable plication is an even more arresting feature of the second or intermediate dilatation, which succeeds the narrow portion.

The intermediate, or second, sinus-like dilatation (figs. 13 to 15 and 17 to 19) of the endolymphatic duct presents all the major morphologic features necessary to subserve the functional rôle ascribed by Guild to this area in the guinea-pig: Extensive folds of epithelium occur, presenting a relatively great amount of surface area (fig. 8), and these rugosities contain cores of vascular connective tissue. Guild [7] observed striking specialization of the epithelial cells lining this area of the duct in the guinea-pig, which we have not seen duplicated in man.

The rugosities in the endolymphatic duct are more pronounced in the adult than in the child, yet the supporting connective tissue is less vascular, and least so in the distal extremity of the duct. Basing judgment solely on anatomic grounds and granting Guild's main contention,[7b] we believe that the complex plicate structure of the intermediate area

12. Although the utricular fold can now be regarded as a constant otologic anatomic feature, one may hesitate to apply to it the term valve. This term includes such morphologically different structures as the pyloric valve, the valves in the great vessels and the valve at the junction of the large and the small intestine—the first consisting of a bulky, circumferential ridge; the second, of delicate and mobile flaps, and the third, of a pair of parallel labia. One might point out that in form (but not in structure) the utriculo-endolymphatic valve bears some resemblance to the last-named structure (fig. 7), but whereas the intestinal orifice is closed by two valvular flaps which come into contact with each other, the utricular duct has a single flap, the opposing utricular wall completing the boundary of the elliptic communication. Like the ileocolic channel, too, the utriculo-endolymphatic duct possesses appreciable length—and is not a mere foramen. But in spite of the general resemblance of the fold within the membranous labyrinth to a labium of the valvula coli, it still does not seem altogether wise to employ for the former structure the term valve, since the term in present-day usage is restricted to mural projections into hollow organs which possess beyond question the function of temporarily closing the lumen of the tube itself or the orifice of a smaller communicating channel.

(second dilatation) of the duct points to concentration there of physiologic activity.[13]

SUMMARY AND CONCLUSIONS

1. Several investigators have shown conclusively that the endolymphatic and related ducts in mammals are complex channels differing in many important respects from the conventional descriptions.

2. The slitlike character of the utricular communication with the endolymphatic duct has been observed to be a striking feature of the duct system; this communication, as has been pointed out by others, is bounded on one aspect by a fold or "valve" (Bast) which anatomically at least is similar to other mechanisms in the body known to be valvular in function.

3. The several dilatations of the endolymphatic duct are observed to be constant features; unlike the usual picture, the endolymphatic duct is considerably enlarged to form a sinus-like space medial to the utricular fold; as it proceeds distally within the vestibular aqueduct, the duct at first narrows and then expands into a second sinus-like space, the walls of which are deeply plicate; these pleats are composed of epithelium over a substratum of loose, vascular, connective tissue. The remaining part of the duct is marked by a decided narrowing and, next, a distal swelling in the region commonly termed the endolymphatic sac; here the plications may be taller, but the underlying connective tissue is much less vascular than that in the region of the intermediate dilatation.

4. In agreement with the interpretation of Guild, we believe that this system of folds answers the anatomic requirements of a resorptive mechanism for the endolymph.

5. Suggestions are offered for a more descriptive terminology—seemingly needed to designate the specialized portions of the endolymphatic duct described in the recent literature.

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13. Guild has suggested the term sinus posterior sacculi for the proximal dilatation of the endolymphatic duct (fig. 8), but sinus primus or sinus proximalis seems to us preferable for the structure in man—sinus primus, since it is the first of a series of three major dilatations in the course of the duct, rather than the sinus sacculi, since we prefer to consider the area as belonging to the endolymphatic duct and not to the saccule. Guild, on observing in the guinea-pig (as we did in man) a constriction succeeding the dilatation just described, termed it the ductus endolymphaticus proprius to distinguish it from the dilatation; for this we suggest the name isthmus proximalis or isthmus primus. For the terminal expansion (largely within the aquaeductus vestibuli) the term saccus endolymphaticus proprius was suggested by Guild. Certainly, the sac must be regarded as more than a mushroom-shaped terminal expansion of the endolymphatic duct, but in man the entire deeply plicate part of the duct is usually divided into two enlargements (intermediate and distal), again separated by a narrowed area. If we were to apply our scheme logically, the intermediate dilatation would become the sinus intermedius or sinus secundus, and the distal (endolymphatic sac), the sinus distalis or sinus tertius.

RETROGRADE SINUS THROMBOSIS COMPLICATING PRIMARY THROMBOSIS OF THE JUGULAR VEIN

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Unusual types of acute suppuration are interesting because they frequently present original problems in diagnosis and stimulate new thought with regard to methods of treatment. Many of the acute suppurative processes of the throat are now well understood, and knowledge of their treatment is by necessity a part of every laryngologist's equipment. When, however, the original infection is followed by extension to remote parts, surprise is often accompanied by doubtful speculation as to the exact diagnosis and method of surgical relief.

The perplexing problem of infection deep in the neck has been illuminated measurably during the past two decades. A phase of this labyrinthic subject which has usually been disclosed post mortem has been brought to our attention by two rare cases, in both of which recovery was obtained. Both patients had retrograde thrombosis of the sigmoid sinus complicating primary thrombosis of the jugular vein. A scrutinizing study of the literature of the past has revealed, to our astonishment, only one similar case in which a diagnosis was made preoperatively and operation was successful. Too little credit has been assigned to W. P. Eagleton,[1] whose case this was, for his remarkable clinical acumen and courage in laying the foundation for the diagnosis of this endocranial complication. Because of the paucity of literature on the subject of infection deep in the neck, we feel the necessity for elaborating the various pertinent facts in these cases in order that the diagnosis may hereafter be more frequently made preoperatively and not at the autopsy table. Fränkel [2] noted the expansion of the thrombophlebitis of the internal jugular vein toward the periphery, that is, toward the skull, proceeding through the pterygoid plexus to the cavernous sinus or by way of the internal jugular vein to the sigmoid or the transverse sinus, in either event terminating invariably in suppurative

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From the Otolaryngologic Service of the Brooklyn Jewish Hospital.

1. Eagleton, W. P.: Cavernous Sinus Thrombophlebitis, New York, The Macmillan Company, 1926.

2. Fränkel, E.: Postanginal Sepsis, Virchows Arch. f. path. Anat. **254**:639, 1925.

meningitis. This intracranial complication occurred in 10 per cent of Fränkel's fatal cases. Wessely [3] pointed out that infection deep in the neck may reach the cavernous sinus along the venous network in the pterygoid region by retrograde thrombosis. Dixon and Helwig,[4] in their series of six cases, discovered retrograde thrombosis of the sigmoid sinus following primary thrombosis of the jugular vein in two cases post mortem. Waldapfel [5] mentioned the possibility of retrograde thrombosis of the sigmoid sinus as a complication of infection deep in the neck. Similarly, Beck,[6] in his series of twenty-four cases, described thrombosis of the sigmoid sinus and tympanomastoid infection as possible complications of parapharyngeal abscess. Mosher [7] stated that it is not unreasonable to assume that in primary infection of the bulb the infection may come by way of the pharyngomaxillary fossa.

ROUTES OF INFECTION

In order to comprehend fully the pathogenesis of retrograde sinus thrombosis from primary thrombosis of the jugular vein, it is essential to describe the various routes of infection from the original focus, the tonsils in most instances.

Hematogenous Route.—Fränkel [2] first indicated that the nature of postanginal sepsis is determined by the occurrence of thrombophlebitis of the tonsillar veins. These thrombi extend progressively until jugular phlebitis is produced. He demonstrated this primary thrombophlebitis of the tonsillar veins in his fifteen cases.

Lymphatic Route.—Uffenorde,[8] who has written entensively on this subject, has not expressed full agreement with Fränkel's theory of a hematogenous route. He has stated that lymphangitis and lymphadenitis constitute the primary process and that secondarily the purulent process extends to the vein, causing periphlebitis and endophlebitis with associated thrombosis. Waldapfel [5] has supported Uffenorde's view and has shown that the invasion into the jugular vein as a result of lymphatic

3. Wessely, E.: Endokranielle Komplikation nach Tonsillitis und Peritonsillitis, Monatschr. f. Ohrenh. **66**:1190, 1932.

4. Dixon, O. J., and Helwig, F. C.: Thrombosis of Internal Jugular Vein as a Complication of Tonsillitis, Ann. Otol., Rhin. & Laryng. **39**:1137 (Dec.) 1930.

5. Waldapfel, R.: Post-Tonsillitis Pyemia, Tr. Am. Acad. Ophth. **33**:291, 1928.

6. Beck, A. L.: Study of Twenty-Four Cases of Neck Infection, Ann. Otol., Rhin. & Laryng. **42**:741 (Sept.) 1933.

7. Mosher, H. P.: Deep Cervical Abscess and Thrombosis of the Internal Jugular Vein, Laryngoscope **30**:365, 1920.

8. Uffenorde, W.: Die Verwicklungen der akuten Halsentzündungen unter besonderer Berücksichtigung der Beteiligung des Spatium parapharyngeum, Ztschr. f. Laryng., Rhin., Otol. **13**:357, 1925.

abscesses may occur not only in one but in numerous places along the course of the vein. These authors have been supported in this contention by Joël,[9] Anders,[10] Greifenstein [11] and Braun.[12]

Continuity Route.—Claus,[13] on the basis of histologic investigation, has expressed the opinion that in the majority of cases of postanginal sepsis the condition originates in abscesses which are found in proximity with the tonsil and that these collections of pus spread deeper into the loose connective tissue of the pharynx and become attached to the walls of the veins, large and small, producing purulent periphlebitis and endophlebitis.

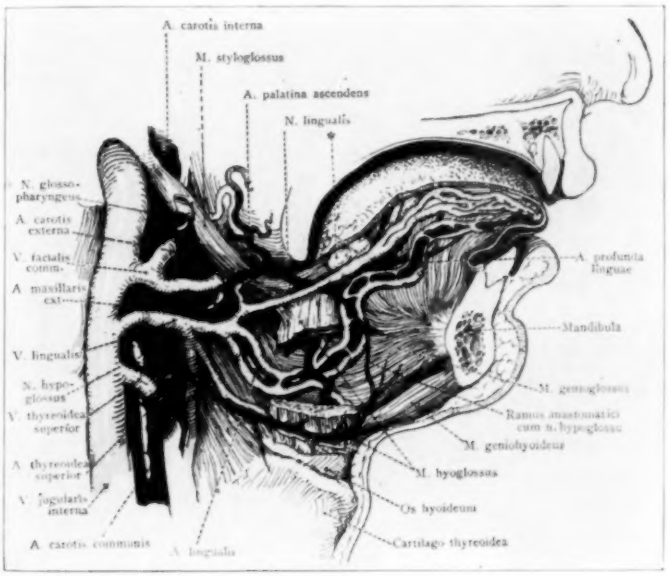

Fig. 1.—Venous drainage from the tonsil by way of veins leading into the anterior facial vein, which empties into the internal jugular vein by way of the common facial vein. Reprinted from Eycleshymer and Jones: "Hand-Atlas of Clinical Anatomy," Philadelphia, Lea & Febiger, 1925.

9. Joël, E.: Deutsche med. Wchnschr. **51**:2133, 1925.

10. Anders, cited by Uffenorde.[8]

11. Greifenstein, A.: Pathologisch-anatomische Untersuchungen über Entstehung und Ausbreitung thrombotisch- entzündlicher Vorgänge im Halsvenensystem unter besonderer Berücksichtigung der nach Gaumenmandelentzündung entstehenden Formen, Virchows Arch. f. path. Anat. **281**:748, 1931.

12. Braun, A.: Sinus Thrombophlebitis, New York, Paul B. Hoeber, Inc., 1928, p. 127.

13. Claus, H.: Achtundzwanzig Fälle von Pyämie nach Angina, Ztschr. f. Hals-, Nasen- u. Ohrenh. **21**:114, 1928.

Tonsillar infection with its complicating parapharyngeal abscess occasionally results in endocranial involvement. To comprehend this problem, it is imperative to visualize the possible routes of infection from the face and neck to the cranial vault. Turner and Reynolds [14] described four such pathways for intracranial pyogenic infection, namely, the

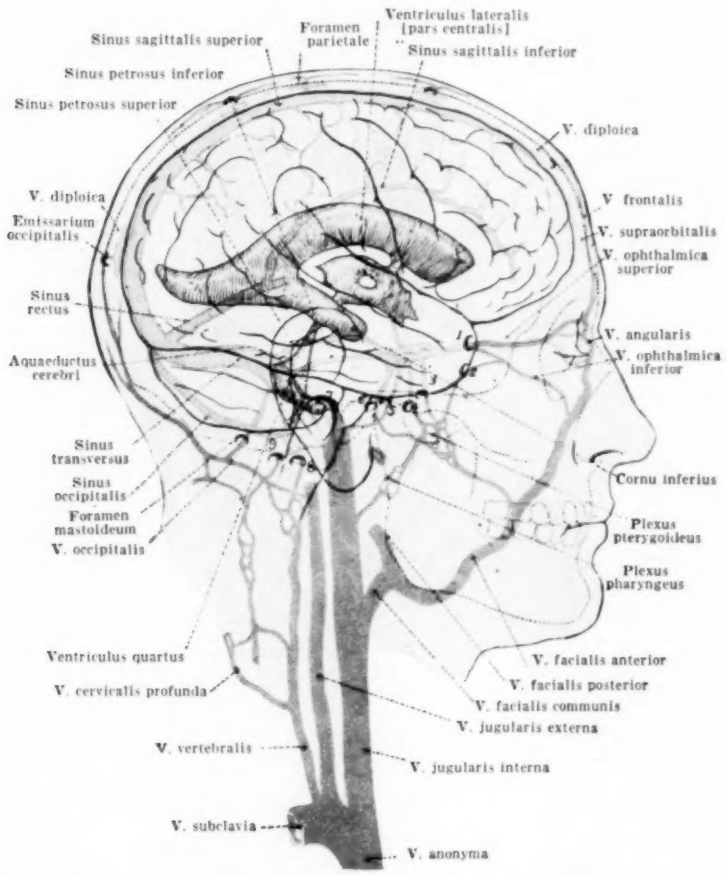

Fig. 2.—The two venous routes of endocranial infection from the tonsillar area. In this illustration *3* and *4* indicate the pterygoid plexus, and *7*, the internal jugular vein through the jugular foramen. Reprinted from Eycleshymer and Jones "Hand-Atlas of Clinical Anatomy."

lymphatic route (which has not been demonstrated pathologically), direct extension through the loss of continuity in bone, the hematogenous route and, finally, the special regional pathways. Infections of

14. Turner, A. L., and Reynolds, F. E.: Intracranial Pyogenic Diseases, Edinburgh, Oliver & Boyd, 1931.

the tonsillar area extend into the skull in most instances by the hematogenous route, so that the other phases may be excluded from this discussion. The two principal hematogenous avenues of extension from the tonsillar fossa are by way of the tonsillar veins into the pterygoid plexus or through the facial veins into the internal jugular vein. Although these venous channels are established anatomic routes for possible endocranial complication from tonsillar infection, the literature fails to reveal many cases in which infection was conveyed in this manner. In order to appreciate the rarity of tonsillar infection as compared with the other cervical and facial sites of primary infection resulting in intracranial pyogenic infection, it is pertinent to describe the six venous routes which empty from the neck and face into the venous sinuses of the cranium. Eagleton [1] described these channels as follows: Infection enters the anterior part of the cavernous sinus from in front by way of the ophthalmic vein. Following an infection of the lip, eyelid, nasal orifice, teeth or anterior part of the mouth, retrograde thrombophlebitis develops, ascends through the angular or facial venous plexus, enters the orbit and is transmitted by the ophthalmic veins to the cavernous sinus. This is also the usual route of invasion in cases of thrombosis of the ethmoid sinus in which the orbit is perforated.

Pterygoid Route (Antero-Inferior).—The infection here reaches the cavernous sinus from below by way of the pterygoid plexus, as it ascends in the pterygoid fossa with its numerous anastomoses from the pharyngeal plexus through the foramen ovale and the deep facial and the inferior ophthalmic veins. In these cases the infection usually originates in a focus in the posterior teeth, jaw or maxillary antrum, less frequently in the pharynx or the tonsils. When phlebitis of the cavernous sinus originates in the tonsil, the path of invasion is generally indirect, involving first the internal jugular vein and from it ascending into the inferior jugular sinus. However, cases are on record in which the thrombophlebitis extended directly from the tonsil into the pterygoid plexus, with which the tonsillar veins anastomose.

Sphenoid Route (Mesial).—The infection extends into the cavernous sinus by way of caries of the sphenoid bone or by thrombosis of the veins which pass through the roof of the sphenoid sinus into the cavernous sinus.

Aural Route (Posterior).—The infection enters the posterior part of the cavernous sinus from the thrombosis of the inferior petrosal sinus or from caries of the deep cells at the apex of the petrous pyramid, where it impinges on the body of the sphenoid bone and unites with the petrous pyramid of the opposite side.

Tonsillar Route (Postero-Inferior).—Infection passes through the pterygomaxillary fossa by way of ascending thrombophlebitis of the

jugular vein. After a peritonsillar abscess or an operation on the tonsil, thrombophlebitis of the tonsillar veins passes through the superior constrictor muscles, giving rise to thrombophlebitis of the jugular vein, from which there is retrograde spread into the jugular bulb and the sigmoid sinus.

Carotid Venous Plexus Route with Direct Spread into the Lumen of the Cavernous Sinus.—This is a microscopic pathway by which infection from the jugular bulb (from either the ear or the throat) extends

Data Showing Relative Frequency with Which Primary Infection in Different Sites Results in Thrombosis of the Cavernous Sinus

	Number of Cases	Total Number of Cases	Percentage
Eagleton (25 cases)			
From infections of face, eyelids, nasal orifice, lips and teeth		10	40.0
Infection of facial wound	1		
Infection of eyelids	2		
Infection of nasal orifice	2		
Infection of teeth	2		
Infection of lips	3		
From antrum and ethmoid sinuses		4	16.0
Infection of antrum	2		
Infection of ethmoid	2		
*From gland in neck		1	4.0
From sphenoid sinus		3	12.0
From ear		7	28.0
		25	100.0
Turner and Reynolds (55 cases)			
From infections of face, eyelids, nasal orifice, lips and teeth		4	7.0
Infection of facial wound	..		
Infection of eyelids	1		
Infection of nasal orifice	2		
Infection of teeth	..		
Infection of lips	1		
From antrum, ethmoid and frontal sinuses		24	44.0
Infection of antrum	3		
Infection of ethmoid sinus	7		
Infection of frontal sinus	10		
Infection of all sinuses	4		
*From gland in neck or throat		1	1.8
From sphenoid sinus		13	24.0
From ear		5	11.0
Unknown or doubtful origin		8	13.0
		55	100.0

through the carotid canal in the skull and thus reaches first the anterior portion of the cavernous sinus.

Eagleton's [1] series of twenty-five cases of infection of the face and neck complicated by intracranial pyogenic disease includes only one case in which the original focus was the tonsil. Similarly, the series of fifty-five cases reported on by Turner and Reynolds [14] includes only one case of tonsillar infection thus complicated. A study of these two important series of cases has enhanced our initial impression of the uncommon occurrence of retrograde thrombosis of the sigmoid sinus extending from primary thrombosis of the jugular vein.

CLINICAL PICTURE

Pus in the neck usually kills the patient by causing edema of the larynx or by burrowing and then bursting its bounds and flooding the larynx, trachea or mediastinum. This dictum, which has been a truism since the inception of modern surgery, must be modified somewhat because of another grave complication of infection deep in the neck, which was lucidly revealed in our two cases as retrograde thrombosis of the sigmoid sinus secondary to primary thrombosis of the jugular vein and infection deep in the neck. Owing to the pioneer efforts of Mosher,[15] laryngologists have become cognizant of the frequency of thrombosis of the internal jugular vein in these cases of deep infection which have heretofore been labeled instances of sepsis of unknown origin. Mosher stressed the import of the carotid sheath, which he aptly termed the Lincoln Highway of the neck, by way of which the base of the skull is reached above and the chest below. By following this sheath, Mosher maintained, one can in most cases readily reach and drain any purulent collection deep in the neck. We suggest, however, that one should not make a detour from this vital highway at the base of the skull if there is any suggestion of intracranial irritation or if the pathologic condition noted in the internal jugular vein does not terminate completely at its upper cervical limit. Even if no intracranial signs are as yet present, this holds true as an invaluable prophylactic measure against invariable extension into the cranial cavity with its too often irremediable complications. Of course, when the upper limit of the jugular vein is apparently normal and shows free bleeding, expectant treatment is logical, with prompt surgical exploration of the lateral sinus in the event of the appearance of signs of persistent sepsis or of neurologic manifestations.

Although the diagnosis of this condition and the indication for surgical intervention may at times be so complicated as to tax one's ingenuity, there are some signs, symptoms and laboratory procedures which we feel are helpful in reaching an intelligent conclusion. First, is the jugular vein involved? In a given case in which there is a history of preceding sore throat and in which there is a supposed uneventful recovery unaccompanied with extratonsillar suppuration, the occurrence, a few days after subsidence, of the classic signs of sepsis, especially if confirmed by blood culture and the development of definite chills, should lead one to examine the neck for the source of the sepsis. A small indeterminate tense swelling just behind and below the angle of the mandible, frequently covered with a few reactionary glands, should lead one to concentrate attention on the side of the

15. Mosher, H. P.: Submaxillary Fossa Approach to Deep Pus in Neck, Tr. Am. Acad. Ophth. **34**:19, 1929.

neck which may be involved. This swelling may be located, as has been found in other cases, anywhere along the course of the jugular vein, but it is always deep under the sternocleidomastoid muscle, is exquisitely tender and is practically never fluctuating. When the lower part of the neck is involved, spasm of the sternocleidomastoid muscle occurs with compensatory torticollis to the diseased side. If trismus is present, indicating extension into the pharyngomaxillary space, one can be fairly certain that the sepsis arises from involvement of the internal jugular vein. If no further signs are presented, exploration of the jugular vein will determine lucidly the extent of the pathologic condition and will indicate the appropriate surgical procedure. If the patient complains of persistent headache or vertigo, vomiting, visual disturbances or any other gross neurologic deviations from the normal, a careful neurologic survey is in order. Of paramount import is the examination of the eyegrounds, because of the relationship of the transverse sinus to choking of the disk, as described by Swift.[16] The presence of edema in either one or both eyes strongly suggests the likelihood of the presence of an obliterating thrombus in the lateral or transverse sinus, although edema may be completely absent if the return circulation of the unaffected side is adequate to assume the added burden. Occlusion of the jugular bulb does not cause choking of the disk in a normally symmetrical development of the sinuses, but marked choking of the disk, unilateral at first and then bilateral, is noted whenever there is an absence of the opposite transverse sinus or a marked decrease in its caliber. Streeter[17] has shown in his statistics that in 89 per cent of all cases there is more development on the right side than on the left. Under normal developmental conditions a block of the sigmoid sinus causes only a partial block of the cavernous sinus of the same side. No appreciable stasis of the blood in the retinal vessels results because the inferior petrosal sinus, draining into the jugular bulb, assumes most of the work usually performed by the superior petrosal sinus, draining into the sigmoid sinus, and the remainder is drained through the annular sinuses to the opposite cavernous, petrosal and sigmoid sinuses and the jugular bulb. If, however, the block of the sigmoid sinus is continued, the lateral and finally the longitudinal sinuses begin to show stasis, which eventually causes a general increase in the capacity of the opposite transverse and sigmoid sinuses. This increase may continue until either compensation occurs or a vicious cycle causes a general increase in the intracranial pressure. In gen-

16. Swift, G. W.: The Transverse Sinus and Its Relation to Choked Disk, Tr. Sect. Ophth., A. M. A., 1929, p. 213.

17. Streeter, G. L.: The Development of the Venous Sinuses of the Dura Mater in the Human Embryo, Am. J. Anat. **18**:145, 1915.

eral, one may say that under normal symmetrical conditions compression or occlusion of the right or the left sigmoid sinus does not cause any change in the ocular fundus. It is only when an asymmetrical development of the venous dural sinuses occurs that the compensatory flexibility of the entire venous system is apparent. In such cases, the appearance of choking of the disk offers a sign of great importance, while the absence of such a sign may easily be misinterpreted if there is normal symmetrical development.

As a cause of these signs of intracranial irritation, one must rule out abscess or tumor of the brain, particularly in view of the fact that in the cases of retrograde sinus thrombosis the clinical picture might be ascribed to any of the various intracranial diseases. However, in the presence of definitely determined thrombosis of the jugular vein, the lateral sinus should be one's first thought. The Crowe-Beck sign and the Tobey-Ayer test also are of great value in establishing the presence of an obstructive lesion in the lateral sinus except in those cases of unilateral rudimentary development of the jugular bulb. The spinal fluid is usually normal except for an increase in pressure, which is found concomitantly with optic edema. One must resort, nevertheless, to spinal puncture to perform the Tobey-Ayer test. A frequent finding is paralysis of the vulnerable sixth nerve, because the long course of this nerve makes it especially susceptible to pressure; in a case of involvement of the posterior cranial fossa it is the first nerve to be paralyzed. It may be pinched as it passes over the apex of this petrous pyramid and under the inelastic petrosphenoid ligament, or the inflammatory exudate of the sinus may compress it between the carotid artery and the bone. In these cases the involvement of the sixth nerve is principally due to the generalized increase in intracranial pressure, to which it seems particularly susceptible.

The otologic examination invariably reveals no abnormality early in the course of the disease. Slight signs of tympanic engorgement and reactionary tenderness of the tip of the mastoid may appear late in the disease. Hearing is normal throughout. Roentgenography is of no diagnostic value. Edema of one or both eyelids may occur, owing to interference with the return circulation, and may confuse the picture by suggesting that ethmoiditis is the cause of the headache, the optic edema and even the sepsis. Here one is confronted with a somewhat difficult diagnostic problem if the ethmoid sinuses are coincidentally involved, although in our cases physical examination and roentgenograms indicated that these sinuses were entirely normal. It is essential also to know that the latent phase encountered in any cases of long-drawn-out suppuration may yield a deceptive normal temperature and blood count. These last two factors should be totally disregarded in

the presence of a definite history of suppuration and positive findings. Blood culture, although it will invariably show positive results at one stage of the process when a proper technic is used, can be misleading by yielding negative results during the latent phases of this prolonged sepsis. The secondary anemia which invariably accompanies this disease is usually constant and is of value both diagnostically and as one of the indications for transfusion. The Schilling hemogram should be followed for prognostic purposes. The occurrence of suppurative metastasis, despite adequate resection of the jugular vein, should suggest at once the presence of retrograde extension into the lateral sinus. This is accounted for anatomically by the geographic portal of entry at the level of the anterior facial vein, which is about 4 inches (10 cm.) from the mediastinum, as contrasted to a scant 1 inch (2.5 cm.) from the jugular bulb. Here also the tendency for the thrombus to extend retrograde is more pronounced because of the mechanical slowing of the blood current and because it is nature's further effort to strengthen the barrier against the entrance of the infection into the blood stream.

The therapy, once the diagnosis is established, is relatively simple. Conservative measures, such as roentgen therapy and poultices, are totally inadequate. In the words of Thomas Carmody of Denver: "Continue the hot poultices to bring fluctuation in deep cervical infection and the abscess will probably open about three days after death." The jugular vein must be exposed in its entirety through an incision extending from the lobule of the ear to the sternoclavicular articulation. As emphasized by Mosher,[15] there is every conceivable advantage in a large adequate incision and no possible disadvantage except the cosmetic results, which should be disregarded in a life-saving procedure. The sternal end of the sternomastoid muscle should be cut to expose the lower end of the jugular vein as it passes under the clavicle along with severance of the lower belly of the omohyoid muscle. All the branches of the internal jugular vein should be carefully severed between ties, and the vagus nerve should be studiously avoided in its course along the posterior wall of the carotid sheath. The internal jugular vein should be cut and tied as low down as possible, the lower end being released momentarily to determine whether free bleeding is present. If the thrombus extends down behind the clavicle, it has apparently, from our experience, shown no tendency to extend any farther. The ligature here, as at the upper end, should be long so as to assist in drainage in case the clot shows a tendency to suppurate. At the upper end, if there should be free bleeding, the operation would be temporarily finished. If, however, pus or an obstructive clot is present here, the lumen of the vessel should be sutured to the skin, forming a fish-mouth fistula, as described by Alexander. Here, as with the otogenic jugular

ligation, we feel that it is advisable to resect all the readily available large glands. This removes a confusing, complicating factor in the convalescence when an inexplicable febrile course may be caused by suppuration in these glands. At this point the lateral sinus should be exposed, regardless of its external appearance, as far posteriorly and inferiorly as possible. We do this because we believe that, as the infection here is intrinsic, occurring from within outward instead of the reverse, as in mastoiditis, the exterior of the sinus and of the vein may give no evidence of the contained pathologic condition. This was clearly demonstrated in our second case. If the external appearance of the vein is so normal as to make one hesitate to operate, aspiration of the sinus with a fine needle should be performed, with due precaution not to penetrate the visceral layer of the sinus. The sinus should then be opened by progressive short incisions starting at the posterior extremity of the exposed sinus, and the bleeding should be controlled with gauze packs until the clot or abscess is reached. When this is accomplished, an obliterating plug should be placed about 1 inch (2.5 cm.) behind the diseased area, and the parietal wall over the thrombus should be completely excised. A small soft rubber tube should then be placed in the bulbar end of the sinus, and its contents should be suctioned out gently. This rubber tube should be left in situ for drainage purposes and for possible through-and-through irrigation by way of the jugular fistula if the suppuration persists. The purpose of obliterating the sinus so far back beyond the diseased area is to render free access in the manipulation of the suction tube and to keep the normal contents of the sinus as far away as possible from the suppurative contents of the bulb.

As for systemic therapy, urgent supportive measures are essential. The use of intravenous injections of 50 cc. of a 50 per cent solution of dextrose, reenforced with a little insulin if there is a tendency to acidosis, serves a double purpose in providing an excellent nutritive element for the weakened myocardium and for relieving the intracranial pressure. The relief from violent headache and the recession of the swollen disks are most spectacular. This relief, strange to say, frequently lasts for from twenty-four to forty-eight hours, although the physiologic effect should be over in a few hours. Repeated transfusions are of inestimable value. Although many otologists consider the hemoglobin level as a fair indication for the use of transfusions, we feel that, even in the early stages, when the hemoglobin value is still relatively high, the immune bodies derived from transfusion have yielded very definite clinical improvement. If possible the donors should be patients who have fully recovered from sepsis due to thrombosis of the lateral sinus. Every large hospital has a fair roster of such patients and would do well to mobilize them as blood donors for such emergencies. The

persistence of optic edema after an otherwise complete clinical recovery should not be disconcerting, as it usually takes several months for an adequate collateral return circulation to develop.

REPORT OF CASES

CASE 1.—S. G., a boy aged 1 year and 8 months, was admitted on June 5, 1935, to the pediatric service of Dr. B. Kramer at the Jewish Hospital. Swelling of the left knee and limitation of motion had been present for five days. The child became sick three weeks previously, with fever and swollen glands on the right side of the neck. Within a few days coryza developed, and the fever persisted. Five days previous to the child's admission to the hospital the left knee became swollen and tender, and there was elevation of the temperature to 103 F. without any chills. The leg was voluntarily splinted by the child. The swelling of the neck, although it had subsided somewhat, was evident at the time of the child's admission to the hospital.

Physical examination revealed acute nasopharyngitis, with a large, firm, well defined mass on the right side of the neck from the midline of the chin to the angle of the jaw. The mass was not tender, and discrete glands were palpated in it. The left knee was full but not red. The patella floated, and the flexion was possible but was resisted by the patient. The tentative diagnosis was acute nasopharyngitis, tonsillitis, acute cervical adenitis, septic arthritis and sepsis.

On the following day the patient was given 125 cc. of whole blood, and there ensued a foreign protein reaction, consisting of urticaria, which responded to treatment with epinephrine. Roentgenograms did not reveal any pathologic condition in the knee. The temperature remained just above normal, and the mass on the right side of the neck was still palpable as a hard, tender phlegmon. On June 10 a transfusion of 200 cc. of whole blood was given. One day later Dr. B. Kramer diagnosed the condition as primary phlebitis of the internal jugular vein adjacent to cervical adenitis. Dr. P. Leibowitz concurred with this diagnosis and advised ligation of the internal juglar vein. Roentgenograms of the lungs revealed no abnormality. The urine showed a faint trace of sugar. A blood count showed: hemoglobin, 75 per cent; erythrocytes, 4,200,000; leukocytes 24,500; stab cells, 7; polymorphonuclears, 68; lymphocytes, 20, and monocytes, 5. Blood cultures persistently showed Streptococcus haemolyticus. The Schick and Dick tests gave negative results. The Kahn and Wassermann tests of the blood were negative. Tuberculin tests gave negative results on two occasions.

Ten days after admission the child was operated on by Dr. P. Leibowitz. A tremendous amount of pus exuded from the region of the carotid sheath and the deep cervical chamber. The carotid sheath was necrotic and thickened, and the inflammatory process extended from about ½ inch (1.3 cm.) above the clavicle to the tip of the styloid process. The entire carotid sheath was involved, and the vein was completely collapsed and adherent to the cervical fascia. The lower end of the jugular vein, which was located in this indurated carotid sheath, was freed, ligated and cut. The entire jugular vein above this point was completely necrotic. Three days later, the child had a temperature of 102 F. and was restless. Hot wet dressings were applied. Ten days later, on June 28, after the temperature had been constant for several days, it began to rise again, and blood culture showed positive results. This recrudescence was attributed to a possible extension of the phlebitic process into the jugular bulb and lateral sinus. The mastoid and the middle ear showed no abnormality. The wound was healed nicely.

A suggestion was made that exploration of the wound be made in order to search for further extension. Roentgenograms of the lungs showed a normal condition, but a roentgenogram of the right mastoid revealed an infiltration in the periantral cells.

On June 30 the course was still septic, and blood culture showed positive results. The fundus of the right eye revealed a slight haze of the inferior margin. Both tympanic membranes were normal. The spleen was just palpable.

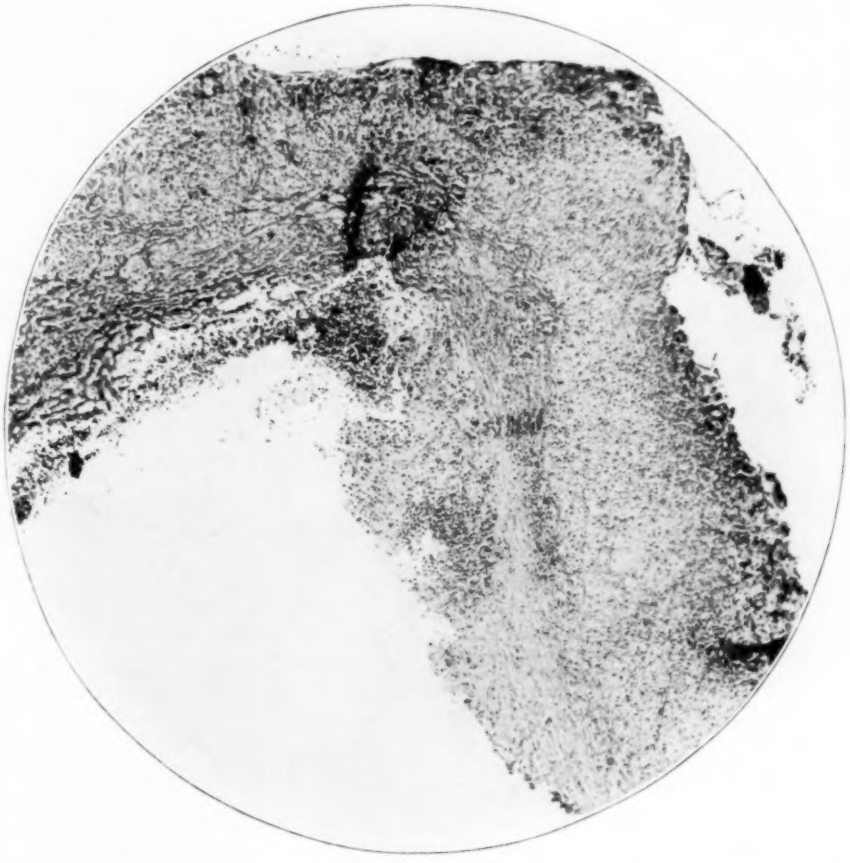

Fig. 3 (case 1).—Low power study of the thrombosis of the wall of the lateral sinus.

Two days later the temperature rose to 102.4 F., and there was a tender mass of glands behind the angle of the right jaw. The right mastoid was somewhat tender over the emissary vein. The right drum was normal. The impression again was that the thrombosis had extended into the jugular bulb and the lateral sinus. On July 8 the fever subsided, and the child appeared to be better. He sat, however, with his head tilted toward the right side. Both drums were normal. In view of this improvement, conservative treatment was pursued. Blood culture showed negative results. The patient was discharged on July 10. Dressings were

taken care of in the outpatient department until July 17, when there was a temperature of from 103 to 104 F., associated with vomiting. The child was readmitted to the hospital. Continued sepsis was once more attributed to retrograde thrombosis of the lateral sinus, but conservative therapy was employed for several days. Blood culture again showed positive results. Two days later, a blood transfusion of 125 cc. was given. A roentgenogram of the mastoid was not remarkable. On July 27 an operation was performed by Dr. F. E. Stone. The right mastoid was opened and appeared normal except for marked congestion. The lateral sinus was exposed and was firm, cordlike and deep red. The wound was left wide open for further exploration later, because of an unsatisfactory myocardial reaction. After the operation two transfusions, each of 125 cc. of blood, were given. Four days thereafter the lateral sinus was incised from the tip to within about 1½ inches (4 cm.) of the knee. The wall was fibrosed and about ½ inch (1.3 cm.) thick. There was a large fibrosed obliterating thrombus which was so adherent to the wall that it could not be dislodged. No bleeding was noted from either the torcular or the bulbar end. The thrombus was not disturbed, but the parietal wall of the sinus was excised. Except for infectious arthritis of the right hip, which responded to conservative therapy, the child made an uneventful recovery, and he was discharged on August 29.

Case 2.—J. M., a girl aged 4 years, was admitted on Nov. 25, 1935, to the private service of Dr. F. E. Stone at the Jewish Hospital. She had swollen glands and a headache. She had been vomiting intermittently for the past two weeks, and there had been swelling of the nose for one day. Four weeks previous to the patient's admission to the hospital the tonsils had been swollen; one week later a swelling developed on the right side of the neck, and a diagnosis of suppurative adenitis was made. The swelling was incised, and it drained for two weeks. One week before admission the patient complained of pain in the neck and right ear and headache. The headache had increased in intensity during the last two days and was persistent. The patient had a stiff neck. She had not had chills, but the temperature was elevated.

On the day of admission the child complained of pain behind the right ear and in the front of the head. There was swelling of the nose and of the right upper eyelid. Physical examination revealed swelling of the tonsils and a tender mass on the right side of the neck extending from the tip of the mastoid to the angle of the jaw. There was no fluctuation, but the child held her head rigid because of this indurated mass. The drum and hearing were normal. Signs of meningeal involvement were not evident, except that examination of the fundi revealed beginning optic edema on the right and a choked disk on the left. Our impression was that the condition was due to primary thrombosis of the jugular vein complicated by retrograde sinus thrombosis, which caused the choking of the disks. The Tobey-Ayer test indicated that the pressure of the spinal fluid was normal, with no increase on compression of either or both jugular veins. Blood culture showed Str. haemolyticus. Roentgenograms of the sinuses and mastoid were normal.

A neurologic examination by Dr. A. Kaplan revealed no evidence of cerebral abscess, confirming the diagnosis of retrograde sinus thrombosis. Two days after the patient's admission to the hospital a mass of adherent glands was removed from beneath the sternocleidomastoid muscle by Dr. F. E. Stone. The internal jugular vein was completely thrombosed down behind the clavicle. Normal vein was not reached at the lower end, from which there was no bleeding. The thrombosed vein was resected to the angle of the jaw, where very slight bleeding occurred when the vein was sectioned. The upper end was left patent, with a

long black suture inserted in the wall. Mastoidectomy was performed, and the lateral sinus was exposed from the bulb to the knee. The mastoid was normal, and the lateral sinus appeared normal except for slight discoloration at the bulbar end. The sinus was incised, and the parietal wall was resected. A large thrombus was present in the lower end of the sinus, with free pulsating pus exuding from the bulb. There was free bleeding from the knee. The sinus was obliterated at the knee, and a single drainage catheter was inserted into the bulbar end. On December 1, palsy of the right abducens nerve was noted. The papilledema had subsided slightly.

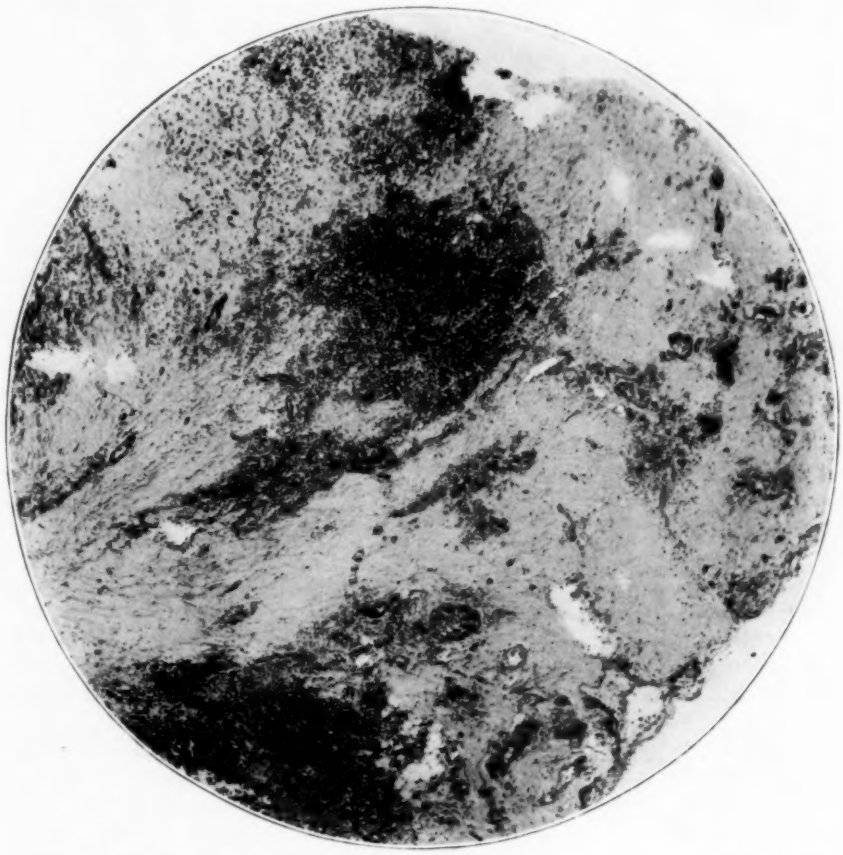

Fig. 4 (case 2).—Low power study of the thrombosis of the wall of the lateral sinus.

Pathologic Report.—There were phlebitic changes in the sinus and in the venous walls, with thrombi. Material obtained by curettage of the mastoid was sterile. Blood from the jugular vein revealed Str. haemolyticus and Staphylococcus aureus. The palsy of the abducens nerve subsided within a few days, but the optic edema persisted for several weeks. The patient was discharged as cured on December 9, after an uneventful postoperative course.

Case 3.—(Eagleton's [1] Case).—There was suppurative thrombophlebitis of the lateral sinus from infected glands of the neck by retrograde thrombophlebitis of the internal jugular vein.

History.—Glandular swelling in the neck had resulted from a sore throat and was associated with slight pain in the ear but no discharge. Incision of the suppurating mass and removal of the enlarged cervical glands were followed by a pyemic temperature, chills and sweating. The ear and hearing were normal. There were no symptoms of cranial involvement, but during the second week marked papilledema developed on the side of the suppurating wound.

Operation.—The lateral sinus was exposed and was filled with pus. There was no bleeding from below. The thrombosed jugular vein was resected in the neck. Its lower end terminated in the fistulous tract left by the original glandular operation. Prompt recovery followed.

Case 4.—(Eagleton's [18] Case).—Pyemia resulted from ascending septic thrombophlebitis, originating in a septic sore throat and adenitis involving the internal jugular vein and retrograding into the jugular bulb and the lateral, petrosal and cavernous sinuses. The only symptom of venous obstruction during the course of the disease was chemosis of the ocular conjunctiva when the head was turned to the opposite side during operation—a symptom of thrombosis of the cavernous sinus not previously described.

History.—Acute swelling of the glands of the right side of the neck was associated with slight redness of the mucous membrane of the throat. For three days the patient did not feel sick and continued to work. Swelling of the gland under the jaw rapidly spread. Culture of material from the throat revealed streptococci.

First Operation.—A deep incision was made just below the angle of the jaw, and a small amount of this pus was evacuated. The wound was then packed with gauze. A few hours later there was difficulty in swallowing. The operation was followed immediately by a high temperature and marked edema of the submucous tissue of the tonsillar pillars of the right side extending into the soft palate. There was no edema of the larynx. The edema of the tonsillar pillars subsided rapidly after removal of the pack from the external wound and disappeared in two days. The pyemic temperature continued, ranging from 99 to 105 F., with perspiration but no chills. Blood culture showed Str. haemolyticus. On the fifth postoperative day the patient had a severe chill and complained of pain in the calf of the right leg.

Second Operation.—The jugular vein was ligated low down in the neck, and free bleeding occurred from the lower end of the vein. The upper end was not investigated, as there was no tenderness or infiltration at the upper part of the neck, where the previous incision was made, or in the pterygomaxillary fossa, which was carefully examined many times, both externally and by mouth. Both wounds healed promptly, but the pyemic temperature continued, with positive results of blood culture.

Third Operation.—An abscess of the leg was incised. During the operation accidental injury to a large vessel in the intramembranous space produced a severe hemorrhage, which necessitated firm packing. A few days later a secondary hemorrhage from the wound in the leg necessitated amputation after a third transfusion. Examination of the amputated limb showed a large area of thrombophlebitis in the intramembranous vein. During the fourth week there was a continued septic

18. Eagleton,[1] p. 66.

temperature without pain. Another transfusion was given in an attempt to control the infection of the blood stream.

Examination During the Fifth Day.—In view of the fact that there was edema of the throat the day after the primary operation on the neck which could be accounted for only by involvement of the superior constrictor muscle and as no other focus of infection could be found as the cause of the streptococcic infection of the blood stream, it is thought probable that there was primary thrombosis of the jugular vein in the stylomaxillary fossa which had extended upward into the jugular bulb and lateral sinus. However, there had never been any localizing symptoms, infiltration or tenderness about the vein, and the original wound in the neck was entirely healed. The eyes, throat and ears appeared normal. The sensorium had been perfectly normal until the day before the examination was made. The patient had been slightly delirious during sleep but rational on awaking. The pyemic temperature, chills and repeated positive results of blood culture were the only evidences of illnesses.

Fifth Operation.—Incision of the lateral sinus was followed by the evacuation of free pus with a foul odor from the lumen. An aseptic clot was adherent to the sinus wall and extended upward 1 inch (2.5 cm.) beyond the knee, where free bleeding occurred. No bleeding occurred from below, although exposure extended well down to the bulb. Within an hour of the beginning of the operation, both ocular conjunctivae became markedly edematous. While the patient's head was turned to the side away from the wound, the neck was extended by a sandbag, which caused pressure on the carotid artery and the jugular vein of the opposite side, and this was believed to be the cause of the bilateral chemosis, which disappeared within a few hours after the head was straightened. Death occurred during the sixth week, while the patient was in coma from meningitis.

Comment.—As there was no bleeding from below the inferior or the superior petrosal sinus, they must have been thrombosed. The infection had extended into the cavernous sinus, causing the occlusion at the time of the last operation, as the pressure on the veins of the opposite side by the sandbags and the turning of the head obstructed the remaining venous pathways.

Case 5 (Kernan's[19] Case).—The patient was ill for seventeen days. Postmortem examination showed a tonsillar abscess extending to the outer side of the superior constrictor muscle in the pharyngomaxillary fossa. The internal jugular vein was thrombosed, the thrombosis extending into the lateral sinus and a short distance beyond the knee. Both petrosal and cavernous sinuses contained clots which extended into the ophthalmic veins. All the clots were partially broken down. There was an abscess in the left temporal lobe. The mastoids were normal.

CONCLUSION

Retrograde thrombosis of the lateral sinus is one of the complications of thrombosis of the jugular vein. This condition should be readily diagnosed and cured by surgical intervention if recognized early.

887 Ocean Avenue.

19. Kernan, John D.: Cavernous Sinus Thrombosis, Secondary to Peritonsillar Abscess, Laryngoscope **31**:384, 1921.

A NEW CLASSIFICATION OF THE BONES FORMING THE SKULL

BASED ON THEIR FUNCTION AND EMBRYOLOGIC ORIGIN AS INFLUENCING THE KIND, COURSE AND FREQUENCY OF INFECTIONS OF THE INDIVIDUAL BONES, WITH SURGICAL APPLICATIONS, ESPECIALLY AS TO THE RELATION OF OSSEOUS INFECTIONS TO MENINGITIS

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PART I: EMBRYOLOGY AND BONE GROWTH IN INFECTIONS OF THE CRANIAL BONES

HISTORICAL BACKGROUND OF SURGICAL TREATMENT OF INFECTIONS OF THE PETROUS APEX IN RELATION TO MENINGITIS

My purpose in this article is to present a brief account of my progressive studies on infections of the petrous apex and to report briefly the case which first awakened my personal interest in the subject.

On Dec. 8, 1926, a young girl [1] who required an operation on the mastoid entered the Newark Eye and Ear Infirmary. After the operation she had pain (*a*) in her head and (*b*) behind her eye. Later she returned, and another operation was performed on the mastoid, during which the surgeon noticed tissue that "looked like cheese." Forty-three days subsequent to the first operation, meningitis developed. At autopsy the petrous apex was found to be eroded and filled with granulations and with caseous material without pus. I concluded that the mass must be tuberculous.

Two months later, on Feb. 18, 1927, another patient presented a similar history of pain behind the eye, with a discharge from the ear, and had, in addition, facial paralysis. At autopsy a similar granulomatous caries was found, with perforation of both the superior and the posterior surface of the apex.[2]

The summer of 1927 was devoted to anatomic dissections in an effort to establish an anatomic route into the petrous apex which would allow adequate inspection of the diseased area. The operation that I selected I termed "unlocking the petrous

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President's address delivered before the fortieth annual meeting of the American Academy of Ophthalmology and Otolaryngology, Cincinnati, Sept. 16, 1935.

1. Eagleton, W. P.: Sixth Nerve Involvement in the Diagnosis and Surgical Treatment of Meningitis of Otitic and Nasal Origin, Compt. rend. Cong. internat. d'oto-rhino-laryng., 1928, p. 822.

2. Eagleton, W. P.: Localized Bulbar Cisterna (Pontile) Meningitis, Facial Pain and Sixth Nerve Paralysis and Their Relation to Caries of the Petrous Apex (Case 2), Arch. Surg. **20**:386 (March) 1930.

pyramid."[3] It was the first operation in the history of medicine by which the petrous apex of a patient whose disease had previously been diagnosed as "suppuration within the petrous apex" was deliberately entered. It was performed on June 30, 1928, after preliminary ligation of the carotid artery. The patient recovered promptly, although the operation so aggravated the localized meningitis that micro-organisms were temporarily free in the cerebrospinal fluid.[4]

At this time I thought that a method had been discovered which would bring about cure in many cases of meningitis, for to have micro-organisms come and go after the drainage of the focus was suggestive.

This case was reported on Jan. 4, 1930,[4b] and the osteomyelitic character of apical infection, that is, the type seen in infection of the marrow of the sinusoidal spaces, was stressed.

PURPOSE OF PRESENT STUDY

From that time apical suppuration has often been regarded from the same point of view as mastoiditis, as if it were an infection within a pneumatic bone, when in reality it is a different pathologic and clinical entity, requiring a different surgical point of view.

But the initial successes—and there was a succession of them—were followed by bitter failures, in some of which the operation on the bone of the apex appeared to precipitate a threatened meningitis.[5]

It was in an attempt to understand why in certain cases infection of the petrous apex causes a recrudescence of meningitis [6] that I undertook a study of (*a*) the embryology of bone, which includes growth of bone, as well as of (*b*) the relative degrees of biocellular and humoral immunity that are inherent in different tissues.

This study forced me to view the bones of the skull from a functional as well as from a morphologic standpoint. And it is the factors of the embryology of the bone, of growth of bone and of the reaction of different bones to infection, a localized immunity—many of these factors being well known to the scientist but neglected by the clinician—that I wish to present. For a consideration of the embryologic and growth factors will help to explain many of the problems presented in cases of meningitis, the meningitis being secondary to the osseous infection, as well as to furnish new points of view for future investigations.

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3. Eagleton, W. P.: The Cerebrospinal Fluid as an Aid to Diagnosis and Treatment of Inflammatory Diseases, J. Laryng. & Otol. **44**:657 (Oct.); 721 (Nov.) 1929.

4. Eagleton, W. P.: (*a*) Unlocking of the Petrous Pyramid for Localized Bulbar (Pontile) Meningitis Secondary to Suppuration of the Petrous Apex (Case 2), Arch. Otolaryng. **13**:386 (March) 1931; (*b*) Tr. Am. Laryng., Rhin. & Otol. Soc. **36**:338, 1930.

5. Eagleton, W. P.: Meningitis—The Result of Disease of the Petrous Apex and the Sphenoidal Basis, Surg., Gynec. & Obst. **60**:586 (Feb.) 1935.

6. See (5) in the "clinical classification of infections of the petrous apex and sphenoidal basis" in a previous paper.[5]

EVOLUTIONARY, EMBRYOLOGIC AND FUNCTIONAL BASES OF DISEASE

Life is the great experimenter. Invertebrates have eyes; also each invertebrate has an apparatus for equilibration, and many forms of invertebrates have mechanisms for hearing, but these are located in different parts of the body (fig. 1).

However, as life evolved in the vertebrate first in the sea and then on the land, in the trees and in the air, with the localization of ganglionic

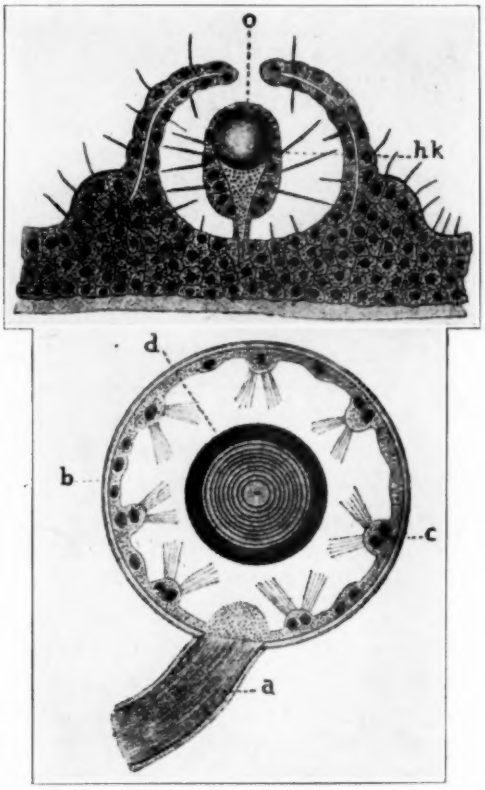

Fig. 1.—The upper illustration shows the vestibular apparatus of Rhopalonema: *o*, the auditory organ; *hk*, the modified tentacle. Note the delicate structure of the exposed position. (Hertwig, reproduced from Morat, J. P.: Physiology of the Nervous System, Chicago, W. T. Keener & Co., 1906.) The lower illustration shows the vestibular apparatus of the mollusk: *a*, the acoustic nerve; *b*, the epithelium of the otocyst; *c*, the ciliated papillae (auditory hairs); *d*, otoliths. The vestibular apparatus is much coarser and more protected than that of Rhopalonema because in life it is exposed to waves. (Reproduced from Morat, J. P.: Physiology of the Nervous System, Chicago, W. T. Keener & Co., 1906.)

masses and then a brain in the forward end of the organism, it evolved, with its growth, special-sense mechanisms, which are in reality additions to its brain.

The lower vertebrates have end-organs for (1) equilibrium and for (2) touch, and the later types, for (3) imperfect sight. (Fishes do not see well.) And then as life crawled out on the land, (4) smell became the dominant sense, for all running things—the rabbit and the deer—recognize their food, their mates and their enemies by smell and by (5) hearing. At last, when life took to the trees, (6) vision dominated life's acts. And with each addition to its special-sense mechanism, a provision for its protection was evolved (fig. 2). So when that strange paradox is reached whose acts often cause one to wonder why he is called Homo sapiens—the wise one, the thinking man—one finds that these special-sense mechanisms and the brain are adequately protected against injury from forces without and from invading micro-organisms within. Consequently, the bones of the skull, made up as they are for the protection of special-sense mechanisms and neural tissue, should be considered not solely from the standpoint of their regional position, as a parietal or temporal bone, but also from that of their use

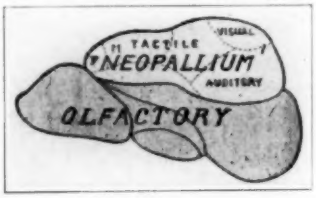

Fig. 2.—Brain of primitive mammal. Note the large size of the olfactory area. There is gradual growth of the visual area in higher forms. (Smith, Elliott: Evolution of Man, London, Oxford University Press, 1927.)

as protectors and retainers of the brain, or of the special-sense organs, through which man's brain receives the external impulses that make up his consciousness.

The bones of the skull are different; almost each fiber is different. In medicolegal trials a small piece of cortex from a bone of a body is recognized largely by its shape. But a bone of the skull can be recognized by its morphology; and not only can its position in the skull be determined, but if the section is deep enough the approximate age of the subject may be surmised with some degree of accuracy.

Dependence of Functional Specificity of Tissue on Its Position as Well as on Its Embryonic Layer.—The theory that the functional specificity of a tissue depends on the embryonic layer from which it evolves in relation to its exact position in the animal frame has not been fully appreciated, although both are of practical as well as of scientific importance.

EMBRYOGENESIS OF BONES OF THE NEUROCRANIUM

Ectodermal Rudimental Radicle in the Growth of the Neurocranium.—The bones of the trunk and extremities spring entirely from mesoderm; that is, cartilage that forms bone in osteogenic areas in embryonal life is composed of mesenchymal tissue, for mesoderm is the sole germinal layer in the formation of the cartilage anlage from which the bones of the trunk and extremities are formed. However, in the skull certain mesodermal cartilages and soft tissues are modified by the addition of an ectodermal quotient (Stone[7]), as during the earliest stage of embryonal growth ectoderm crawls over the mesodermal bed of the head. And it is the addition of this vitalizing growth moiety that gives these bones their distinctive neurocranial character, for without this ectodermal moiety, neurocranial cartilage and some of the cranial soft tissues do not develop. Thus, an ectodermal quotient—ectoderm, from which pure nerve tissue is formed—becomes the vitalizing moiety of a neurocranial bone in its growth from a somatic mesodermal stratum.

Development of Neurocranial Bones by Modification of Established Stages of Somatic Bone Growth.—Further, life has adapted each cranial bone to its own functional position by modifying morphologic patterns that had become established in the growth and development of the somatic bones[8] of the trunk and extremities. This modification life accomplished by adding to, omitting from or combining the usual stages of bone growth differently, so that new forms of bone—a neurocranial bone—emerged from alterations in the usual growth processes. And the specific type of growth is inherent in the particular group of cells of each functionally different domain (Coghill[9]). Thus, to grasp the significance of a bone of the skull requires a consideration of four factors: (*a*) embryologic origin, (*b*) functional use, (*c*) stage of growth and (*d*) position in relation to contained organs and to surrounding structures. The differences in the morphology of the cranial bones are explained by variations in the (*c*) manner of the growth of the bone in the embryo and during later life.

PROCESSES OF BONE GROWTH

In a very general way, there are two kinds of somatic bone: (1) compact tissue bone, which is formed at the periphery by the periosteum,

7. Stone, L. S.: Problems Concerning the Origin and Development of the Neural Crest and Cranial Ganglia in the Vertebrates, Yale J. Biol. & Med. **1**:7 (Oct.) 1928.

8. Fell, H. B., and Robinson, R.: The Growth, Development and Phosphatase Activity of Embryonic Avian Femora and Limb-Buds, Biochem. J. **23**:767, 1929.

9. Coghill, S. E.: Anatomy and the Problems of Behavior, London, Cambridge University Press, 1929.

viz., periosteal bone, and (2) cartilage bone, which is formed centrally from what is called a cartilage "anlage"—a cartilage nest.

Osseous Formation and Endothelial Protoplasmic Penetration in Bone Growth.—There are in the growth of bone two distinct processes: (1) osseous formation characterized by the deposit of calcium salts and (2) protoplasmic vascular penetration, a reticulo-endothelial infiltration of red bone marrow into the osseous stroma, for bone marrow should be regarded as primordial vascular endothelial tissue (Smith [10]).

Growth in Somatic Bones.—The growth of a bone is accomplished by (1) deposition of, and later by (2) absorption of, calcified cartilage and then of osseous tissue. All bone growth is a process of (1) depositing and (2) absorption, the latter being accompanied by (3) differentiated division for function, all being perfectly synchronized, while the growth processes act both (1) in the center and (2) at the periphery.

Growth Process in Somatic Bones.—The bones of the trunk and extremities form by a combination of three processes of growth. The first, endochondral growth, results both in (*a*) cartilaginous ossification and in (*b*) endothelial protoplasmic permeation. In a long bone, central endochondral growth is accompanied by the formation of periosteal bone at the periphery, for it is this formation that furnishes the growth increments which form the cortex encapsulating the bone. And in a manner analogous to that by which an advancing proliferating new connective tissue absorbs the senescent calcified cartilage cells [11] within the central stroma while it deposits mineral salts and thus forms osseous tissue periosteal bone growth is accompanied by absorption of the centrally formed endochondral osseous elements in the interior of the bone.[10] As a result, the final structure of bone comes from bone cells furnished by the periosteum, with little of the original cartilaginous framework remaining.[12] At the same time, this vascular fibrous absorption from the periphery creates additional space in the body of the calcified cartilage for the deposition of protoplasmic endothelial bone marrow, which is evolved in the new connective tissue that has formed in the central calcified cartilage, for every haversian canal is a prolongation of the central marrow system.

Each bone during its period of growth passes through three stages, (*a*) youth, (*b*) maturity and (*c*) old age; like every person, it becomes senescent—senile.

Consequently, a study of the embryologic development of each bone in relation to (*a*) its function and (*b*) its method of growth, as it passes

10. Smith, J. Lorrain: Growth, London, Oliver & Boyd, 1932, p. 84.

11. Harris, H. A.: Bone Growth in Health and Disease, New York, Oxford University Press, 1933.

12. Leriche, R., and Policard, A.: The Normal and Pathological Physiology of Bone, St. Louis, C. V. Mosby Company, 1928.

to maturity and then becomes senescent, helps to explain the different (1) reactions to different forms of infection in the different bones as well as the (2) course that each type of infection will take in that particular bone. One bone of the skull, the labyrinth of the new-born babe—the neonatal labyrinth (fig. 3)—passes maturity and becomes senescent at birth. And because it is senile it loses most of its vessels while the fetus is still in the mother's womb. Another bone, the base of the sphenoid, never grows senile. For this bone should be considered not simply as a supporting and mechanically protecting bone but as an actively functioning organ, an organ that operates throughout life.

Fig. 3.—Infant skull. The mastoid grows outward by pneumatization to protect the labyrinth during the first two years.

CLASSIFICATION OF NEUROCRANIAL (FAWCETT) BONES ON BASIS OF FUNCTION

From a functional standpoint, the skull is made up of (1) facial bones and (2) neurocranial bones. The position and function of the latter are dictated by their relation to neural tissue. All facial bones that are below the eyes are for the protection of and the carrying on of the respiratory and digestive activities of the organism Facial bones have but slight relationship with the brain.

For a better understanding of their function, I suggest that neurocranial bones be divided into (1) the bones of the cranial vault, which evolve from membrane; (2) special-sense (compact tissue) bones, which

spring from cartilage; (3) passively protective (pneumatic) special-sense bones, such as the mastoid, which develop from a combination of cartilage and membrane, and the (4) biocellular actively protective bones of the base of the skull, which contain red bone marrow and continue the morphologic pattern seen in somatic bones, that is, in the ring-shaped vertebrae, the encircling ribs, the pelvis and the long and short bones of the extremities.

1. *Neurocranial Bones of the Vault of the Calvarium.*—These bones grow from membrane; they do not spring from cartilage. They are (*a*) appositional or (*b*) membrane bones. The internal plate of the bones of the vault grow, with the dura, outward, while the external plate forms from the soft parts and grows inward.

The membrane bones of the vault begin their growth during fetal life. At birth they are separated and incompletely formed, but the two large soft spots in the infant's skull gradually close during infancy. Further, throughout maturity, that is, from puberty on, the bones of the cranial vault are filled with red marrow, only to lose this protoplasmic endothelial marrow during the general senescence of old age.

Surgical Consideration of Osteomyelitis of the Cranial Vault.—During growth and throughout maturity vessels run into the bones of the cranial vault from the dura within and the soft part externally (Furstenberg[13]). Thus, an invasive type of osteomyelitis of the vault of the skull is apt to be accompanied by (*a*) a subperiosteal abscess, because of the vascular supply of the bone. And furthermore, if the vitreous plate is involved there is always (*b*) an extradural abscess and frequently (*c*) a subdural abscess. Consequently, it should be a dictum that if osteomyelitis of the skull is associated with headache, lumbar puncture should be performed, and if the cell count is high, the dura should be opened.

2. *Special-Sense Bones.*—These are composed of compact bony laminae, which grow with the end-organ that they harbor. Special-sense bones spring from cartilage and are largely without vessels, and for this reason they cannot be the primary seat of an infection.

Surgical Consideration of Infection of a Special-Sense Bone.—Because the labyrinth is a unique special-sense capsular bone, it is the seat of a specific disease, otosclerosis, and all attempts to consider otosclerosis as a form of disease of the bone such as is found in any other bone are destined to fail. The changes in otosclerosis are allied to those in osteofibrosis, but the conditions are not the same, for in the former the changes occur only in a specific bone—the osseous labyrinth—that has a specific function, the protection of the highly specialized membranous labyrinth.

In my opinion, otosclerosis is a dystrophy of that unique type of bone growth which produces man's idiocratic special-sense labyrinth, as cancer probably is a

13. Furstenberg, A. C.: Bone Regeneration in Osteomyelitic Defects of the Cranium, Tr. Am. Laryng., Rhin. & Otol. Soc. **36**:434, 1930.

dystrophy of all forms of tissue growth;[14] but cancer may occur in any species and in any tissue, while otosclerosis is confined to the bony labyrinth capsule of man.

Furthermore, there is no evidence that either trauma or venous stasis causes otosclerosis. And to do so, the trauma or venous stasis would have to occur either during fetal life or in infancy, that is, while the labyrinth capsule is growing.

3. *The Passively Protective Special-Sense Bones.*—This group is made up of the pneumatic bones. They grow from cartilage but have a covering of membrane bone. Lateral expansion of bone by pneumatic growth in the mammal is a form of growth of cranial bone. The function of a pneumatic bone is to protect its special-sense organ against external violence and infection.

A baby does not need a protecting mastoid for its labyrinth, because it is not subject to external violence; thus expansion of bone by pneumatic growth begins only at birth.

On the other hand, the function of "overflow pneumatization" is for rectifying inequalities in the surface of bones that may have appeared during the development of adjacent bones. Overflow pneumatization occurs around the labyrinth and into the petrous apex during the second growth cycle, at the age of from 5 to 10 years.

Clinical Consideration.—(*a*) Mastoiditis in Infancy: During infancy the spaces between the cartilage anlage, which forms the bone of the labyrinth, and the surface membrane bone that covers it are filled with infantile fat, with the result that mastoiditis in an infant is a true osteomyelitis accompanied by severe constitutional disturbances, especially diarrhea (as first brought out by Dean[15]), because the gastro-intestinal tract, not having acquired its full functional growth, is in an unstable condition.

(*b*) Mastoiditis in Children: After a passively protective pneumatic bone is fully developed it contains few vessels; consequently, infection is likely to be limited within the bone itself. The ordinary so-called "confluent type of mastoiditis" that occurs from childhood on can be defined as a "localized osteitis of a pneumatic bone."

4. *Actively Protective Bones of the Base of the Skull.*—These bones grow in utero by an embryonic hemato-endothelial infiltration within the cellular structure of cartilage bone. Thus, the bones of the base of the skull after birth contain a protoplasmic mechanism. The function of these dynamically operating organs is to protect, throughout extra-uterine life, the meninges covering the base of the brain against infection from without.

The supreme example of actively protecting biocellular neurocranial bone is the base of the sphenoid, for, although the sphenoid air sinus

14. Lockhart-Mummery, J. P.: The Origin of Cancer, London, J. & A. Churchill, Ltd., 1934.

15. Dean, L. W., and Armstrong, M.: Nasal Sinus Disease in Young Children, Ann. Otol., Rhin. & Laryng. **28**:445, 1919.

frequently becomes infected from "a cold," the red bone marrow within its spongiosa operates to overcome the micro-organisms.

CLINICAL CONSIDERATION.—(*c*) Pneumococcic Meningitis of the Sphenoid Sinus of Small Vein Origin and Streptococcic Meningitis from Sinusoidal Osteomyelitis: The number of cases of abscess of the brain from an infected sphenoid sinus are few—about six cases in the literature—and meningitis occurred in two forms: (*a*) pneumococcic meningitis following an infection confined to the blood vessels of the submucosa, and (*b*) streptococcic meningitis from sinusoidal osteomyelitis.

Meningitis due to infection of the sphenoid sinus is almost always of pneumococcic origin, because the organism has a capsule and grows in the blood vessels in the bone.[16]

PROGRESS IN THE UNDERSTANDING OF MENINGITIS IN RELATION TO INFECTIVE LESIONS OF AN ADJACENT BONE

It has long been known that suppuration within a bone of the skull is the cause of meningitis in about 65 per cent of all cases. Fifteen years ago I demonstrated that during the initial stage meningitis is likely to be confined to a localized area,[17] and that if the fluid within the infected arachnoid cistern is evacuated early, the process is generally controlled. Several years later I found that disease of the vessels from the bone into the meninges[18] was the cause of meningitis in at least 20 per cent of all cases. The remaining 15 per cent have been considered of unknown origin. But today I know that many of this 15 per cent are cases in which infection has reached the meninges from the petrous apex or from the base of the sphenoid, although the infection, which is the cause of the meningitis, being within the red bone marrow, is frequently overlooked, even at postmortem examination. This is because the red marrow within the bones of the base of the skull does not react to infection by the production of visible necrosis of the bone with the formation of pus until days and even weeks have passed. The microscopic wont of infection of the marrow is illustrated in a case of osteomyelitis occurring in a long bone of a child in whom early cutting through the cortex reveals what is apparently normal marrow (Ban-

16. Eagleton, W. P.: Meningitis from the Sphenoid, Tr. Am. Laryng., Rhin. & Otol. Soc. **38**:51, 1932.

17. Eagleton, W. P.: The Operative Treatment of Suppurative Meningitis with Especial Reference to Irrigation of the Cranial and Spinal Subarachnoid Spaces, and the Importance of Protective Meningitis from a Prognostic and Therapeutic Standpoint, with an Analysis of the Cases of Recovery—Exclusive of Meningococcic—Reported in the Literature, Tr. Am. Otol. Soc. **15**:227, 1921; The Operative Treatment of Suppurative Meningitis, Atlantic M. J. **26**:575 (June) 1923; The Surgical Treatment of Meningitis, J. A. M. A. **83**:1900 (Dec. 13) 1924.

18. Eagleton, W. P.: Suppurative Meningitis of Otitic and Nasal Origin: Its Relation to Blood Stream Infection of the Pial Vessels, Arch. Otolaryng. **15**:885 (June) 1932.

croft), although the disease is accompanied by pain, high temperature and local tenderness. However, the incision usually stops the infectious process.

Infection by Vascular Pathways.—In involvement of the marrow-containing base of the sphenoid or petrous apex microscopic examination reveals that infected blood vessels often enter directly into the meninges, in which case the patient is likely to succumb from meningo-

Fig. 4.—Hemorrhagic infiltration in the basal ganglion in a case of meningoencephalitis.

encephalitis long before there is any chance of infection of the bone marrow having developed which is discernible to the naked eye (fig. 4).

Thus, the whole problem of meningitis developing from infection of a marrow-containing bone of the skull is largely a question of how to control an infection which passes through or from a bone by way of blood vessels.

Relationship of Vascularity of Bone to Growth and the Dynamic Function of the Bone Marrow in the Control of Infection.—The somatic

bones of a new-born mammal before it walks are red and soft because of a free vascular supply and because of the red marrow content. But in the full grown steer the bone is ebony-like and composed of a firm white cortex enclosing yellow fat marrow, because during the process of growth the vessels have disappeared, the trabeculae of the medulla have been absorbed and the invading red marrow has become fat, while its periosteal cortical bone has been converted into senescent bone. A similar process occurs in the petrous apex; it grows, and when it reaches maturity its cellular marrow turns to acellular fat.

Metaplastic Differentiation from Yellow Fat to Cellular Red Marrow.—Custer [19] has shown that in the long bones of a chicken the acellular fat marrow can become cellular red bone marrow in two days in response to the stimulus of an infection or of cancer.

This also occurs in tumor of the brain.

I recently examined the apexes of a patient who had died of an infiltrating tumor of the temporal lobe of the brain. The neoplasm had been slowly increasing in size, with but slight vascularity, for about two years. During life he had had the typical symptoms of involvement of the uncinate gyrus; he would smell a peculiar odor and then have a convulsion. At autopsy both petrous apexes were filled with mahogany-colored bone marrow, whereas normally the apexes are filled with yellow fat or with air cells after about the eighth year.

Why this mahogany-colored, actively functioning bone marrow? It was the result of the conversion of the adipose tissue within the apex into cellular marrow—a hemogenic response from irritation of the growth.

The Apex, a Reticulo-Endothelial Unit of the Base.—The petrous apex should be regarded as a local depot or unit of the reticulo-endothelial system of the base of the skull, and when it is filled with red bone marrow, it reacts by hemogenic activity, this being its response to an abnormal stimulus which has entered the circulation from adjacent tissues.

PART II: INFLUENCE OF EMBRYOLOGIC ORIGIN AND STAGE OF BONE GROWTH ON INFECTION IN THE TEMPORAL BONE FROM THE SURGICAL POINT OF VIEW

DIFFERENT FORMS OF OSSEOUS TISSUE IN THE TEMPORAL BONE

The mammalian temporal bone contains the highest forms of specialized osseous architecture that have been evolved by life. The bone

19. Custer, R. P.: Studies on the Structure and Function of Bone Marrow: I. Variability of the Hematopoietic Pattern and Consideration of Method of Examination, J. Lab. & Clin. Med. **17**:951 (July) 1932.

consists of three distinct parts, placed side by side, each having sprung during intra-uterine life from a separate mass of cartilage, which together make up the primordial base of the skull of the fetus.

For the designations of the functional differences that exist between the genetically distinct forms of bone composing the temporal area of the neurocranium, I suggest the terms: (1) passively protective special-sense (pneumatic) bone (of the mastoid); (2) special-sense (compact) bone (of the labyrinth), and (3) actively protective somatic (spongiose red marrow-filled) bone (of the petrous apex portion of the base of the skull).

THREE STAGES OF BONE GROWTH IN THE TEMPORAL BONE OF THE NEW-BORN

Not only is the os temporale of the new-born child [20] made up of three varieties of neurocranial bone, but each is in a different stage of bone growth.

The fat-filled, passively protective special-sense rudimentary domain of the mastoid is placed superficially; its lateral extension outward by pneumatic bone growth begins as the infant assumes respiratory life.

On the other hand, the mesially placed petrous apex is made up of actively protective, marrow-filled spongiose bone, the biocellular somatic osteogenesis of which, beginning in the fetus coincident with the establishing of the circulation of the blood at about the fourth and one-half month of uterine life, is continued through infancy and into childhood, that is, as long as the bone increases in size. Afterward the bone of the apex becomes senescent as a proliferating growth organ.

Safely placed between the passively protecting antrotympanic mastoid and the proliferating apex is the special-sense labyrinth capsule, the nonvascular compact tissue bone of which has passed through maturity and become senescent bone prenatally.

LABYRINTH CAPSULE

Senescent "Neonatal Labyrinth Capsule" of the New-Born.—The bony labyrinth is the opus maximum of specialized bone architecture that has been evolved by mammalian life. The ebony-like labyrinth of the infant—for which I offer the designation "neonatal labyrinth capsule"—must be differentiated from the matured capsule of childhood. The latter is formed by the neonatal capsule's becoming incompletely surrounded by a "secondary bone shell." The neonatal labyrinth is made up of endochondral bone. It springs from an idiocratic cartilage

20. Cheatle, A. H.: Surgical Anatomy of the Temporal Bone, London, J. & A. Churchill, 1907, pp. 16 and 17.

anlage during fetal life, which in turn comes from the otic vesicle of the embryo. Its ossification begins as early as the fourth month of fetal life (coincident with the "quickening of the child") and continues through the remaining months. It is thus full-sized senesecent bone at the time of the birth of the child. Thus, not only the (*a*) pattern of growth of the bone of the neonatal labyrinth capsule, but also the (*b*) osteogenic process forming it are unique, for it is the only bone in the body which at birth is (1) full-sized and (2) composed of senescent bone without vessels.

Surgical Consideration of Labyrinthine Infections.—The bone of the primitive neonatal labyrinth is impermeable to all types of infection because of the

Fig. 5.—Infant's labyrinth, full-sized at birth, compared with adult bone. The temporal bone grows outward by pneumatic growth of the mastoid and inward by the growth of the bone marrow of the apex.

(*a*) ivory-like nature of the compact tissue which forms it and because of the (*b*) absence of nutrient blood spaces within the bone.

"Matured" Labyrinth Capsule of Childhood.—Outside the labyrinth there grows, during infancy, peripherally formed periosteal bone, and this is filled with blood vessels. The manner of growth of the shell over the neonatal labyrinth is analogous to the growth of a deer's antlers; that is, the bone grows from a periosteal vascular bed which forms the spring-time fuzz on the deer's antlers.[21]

21. MacEwan, W.: Growth and Shedding of the Antler of the Deer, Glasgow, Maclehose, Jackson & Sons, 1920.

Secondary Ectochondral, Peripherally Formed Periosteal Bone in Areas of the Labyrinth Capsule.—During the first years of postnatal life the peripheral growth increments begin to form ectochondral bone around the neonatal labyrinth in definite areas, which continues to be highly vascular as long as the "secondary periosteal shell" is growing. Some of these areas continue as cancellous bone throughout life, although their nutrient channels are empty of blood after the completion of the growth of the bone. However, many of the vascular channels are still pervious to very small particles, as such particles can be artificially introduced into them by pressure from the neighboring venous radicles which empty into the jugular bulb. These empty minute microscopic plexuses, which are especially numerous within the solid angle of the petrosal, I have designated "points of venous vulnerability," [22] for they are potential pathways through which in inflammatory congestion infection—especially that due to the encapsulated pneumococcus—often invades a venous sinus, giving rise to infective thrombophlebitis or a phlebitic process that may extend inward into the arachnoid mesh and result in local or general leptomeningitis.

Surgical Consideration of Perilabyrinthine Infections.—Influence of Vascularity as Affected by the Maturity of the Bone on the Formation of Caries in Areas Adjacent to the Neonatal Labyrinth: Thus, the exemptions from infection of the compact bone of the neonatal labyrinth do not apply to the perilabyrinthine areas, which are formed of secondary appositional bone, for the cancellous bone of the incomplete peripheral shell that develops during the first two years of life may be the seat of a long suppurating sinus. Such a fistula may extend above, behind or below the labyrinth and may enter the petrous apex. Consequently, in cases in which there are symptoms of apical irritation, the surgeon, during operation, should thoroughly investigate the bone (1) within the solid angle of the petrosal and (2) about the eminentia arcuata as well as (3) in the supratubal region before perforating into the apex itself. For if the external orifice of a fistula is found, it will furnish a "tract" to that part of the apex which is the site of the suppuration.

VARYING FORMS OF REACTION TO INFECTION FROM GENETICALLY DIFFERENT BONE

Each of the three genetically different bones—(*a*) the pneumatic protective special-sense bone of the mastoid, (*b*) the unique special-sense bone of the labyrinth and (*c*) the somatic marrow-filled bone of the apex—has a specific histologic structure because of its genetic origin, and in each area the reaction of the bone to infection is different, which reaction is modified by the stage of growth in which the bone is at the time it is attacked by disease. Thus both factors, (*a*) the genetic origin

22. Eagleton, W. P.: The Cerebrospinal Fluid as an Aid to Diagnosis and Treatment of Inflammatory Diseases, J. Laryng. & Otol. **44**:657 (Oct.) 1929.

of the bone and (*b*) the stage of its growth, have an influence on (1) the type of the infective lesion present and (2) the course that the disease will take.

DEPENDENCE OF THE PATTERN OF BONE GROWTH ON THE PLAN OF BLOOD SUPPLY

The morphologic structure of a bone is largely dictated by the pattern of its blood supply. This, in turn, depends on whether the osteogenic growth process which is present at the moment is solely vegetative, that is, for osseous proliferation, or is for the differentiation of a specialized function. A combination of vegetative proliferation and functional differentiation is the osteogenic process usually active during the expanding periods of skeletal growth, although it is a fundamental law that active growth and specialized differentiation are mutually inhibitory (Boyd [23]).

PNEUMATIC GROWTH

The Osteogenesis of the Pneumatic Protective Special-Sense Mastoid Apophysis; Protection of the Olfactory Domain as Furnished by the Pneumatic Portion of the Respiratory Ethmoturbinal Nasal Capsule.—The bones of the (1) mastoid apophysis and the (2) respiratory portion of the nasal capsule expand by pneumatization. This pneumatic growth occurs during the first general "filling-out cycle" in infancy. But the growth of the skull does not run parallel with the growth in the size of the body, as the growth of cranial bone is regulated by the demands of its protective nature, protection (1) from external trauma or (2) against invasion by micro-organisms being required, as well as an increase in the size of the (*a*) face and of the (*b*) neural tissues of the brain and its end-organs, each of which factors comes into play at different periods of fetal, infantile and childhood life.

Bones that expand by pneumatic growth are "surface" bones. The environmental requirements for the growth of protective pneumatic bones in mammals are: previous ossification in the fetus from a cartilage anlage, with a layer of "investing" membrane bone covering, the bone spaces between the two strata of genetically different bone being filled with infantile fat at birth. It is the entry into this fat-filled cleft of a rapidly proliferating surface epithelium from the upper respiratory tract that furnishes the stimulus resulting in pneumatic bone growth during infancy and early childhood.

Pneumatic Growth in the Antrotympanic Domain.—The growth of the small pneumatic cells of the mastoid, to furnish protection to the

23. Boyd, W.: Growth, Normal and Abnormal, J. A. M. A. **105**:1520 (Nov. 9) 1935.

labyrinth from external violence, is very active during the first year of infancy. Pneumatic growth then progresses slowly but evenly up to maturity as a part of the general growth filling-in process. Thus, in the antrotympanic domain, immediately on the assumption of respiratory life, pneumatic growth begins between the bone which sprang from the cartilage anlage of the antrolabyrinthine capsule and its membrane-bone covering. This area in the fetus had developed from primordial cartilage of the base of the skull, to which an element of branchial arch cartilage (Reichert's cartilage) and an ectodermal quotient (Stone [7]) had been added. Pneumatization occurs by this cleft's being invaded by a rapidly proliferating epithelium [24] from the upper respiratory tract. This invading epithelium, while absorbing the primitive mesenchyma (Wharton's jelly) that fills the cavity of the tympanic antrum and laying down an epithelial lining, replaces the infantile fat that fills the spaces in the primitive mastoid. The rapidly proliferating epithelium thus converts the antrotympanic cavity and the primitive mastoid spaces into pneumatic cells, furnishing them with a thin epithelial lining. A multiplication of new pneumatic cells now becomes the osteogenic process to complete the lateral expansion of the cranial base outward. This growth process of pneumatic expansion proceeds very actively during infancy, continuing slowly for about the first three years. During this time air cells frequently extend into the zygomatic and squamous areas of the temporal or even the occipital bone. It is a later extraterritorial pneumatization that invades the petrous apex in about 35 per cent of persons, but this happens only after the apex has stopped growing, its red marrow having been converted into "acellular fat."

Summary of Pneumatic Growth of the Mastoid Apophysis: Thus, the mastoid apophysis is a neurocranial protective special-sense (vestibulo-auditory) bone. It increases in size by osseous palingenesis (Haeckel), that is, through the successive formation of additional small air-filled spaces (Eagleton [18]) of the parent type. The outer wall of the mastoid apophysis is "ballooned outward," as it were, from the domain of the tympanic antrum by peripherally formed pneumatic bone growth during infancy and childhood.

Function and Pattern of Pneumatic Bone Growth.—The development of mammalian pneumatic bone is a type of passively protective surface special-sense meso-ectodermal archegenesis. Pneumatic bone growth in the mammal is a specialized modification of the pattern of bone growth which was evolved by avian life. The function of pneu-

24. Wolf, Dorothy: The Microscopic Anatomy of the Eustachian Tube, Ann. Otol., Rhin. & Laryng. **43**:483 (June) 1934.

matized bone in birds is the storage of oxygen during prolonged flight [25] and the acclimatization of the animal to variations in oxygen and carbon dioxide equilibrium. In the mammal, pneumatic bone growth is an adaptation of "surface membrane" bone, its specific function being the protection of the special-sense end-organ for hearing against violence and of the domain of the special olfactory sense against infective organisms, which are constantly entering the nose.

Surgical Consideration of Infections of Pneumatic Bone.—1. Limitations of Infection in Coalescing (Kopetsky) Mastoiditis Due to Pattern of the Blood Supply of the Mastoid: The blood vessels that develop during pneumatic "ballooning outward" during the growth of the auditory domain run in the submucosa of the proliferating epithelium that lines the mastoid cells. These vessels, once the growth of the apophysis has been completed, have no communication with the deeper adjacent tissues; consequently, the infections which ordinarily travel by direct continuity of tissue suppuration are likely to remain localized in the mastoid cells, provided that they occur after early childhood, that is, after the absorption of the infantile fat in the bone. However, during infancy infections of the mastoid are osteomyelitic processes because of the presence of fat marrow.

Senescent pneumatic bone, after completion of growth in early childhood—such as the fully developed mastoid cells—reacts to infection by transudation of cells (leukocytes and erythrocytes), which are brought to it by the circulation.

2. Limitation of Abscess Formation in Mastoiditis in Relation to Blood Supply: Mastoiditis of the confluent carious type is likely to be associated with the formation of an abscess, the abscess being limited by a layer of granulation tissue, round cells and phagocytosing polymorphonuclear leukocytes, which are brought to the mastoid by the hematic circulation.

RED BONE MARROW IN INFECTION

The Reaction of the Endothelial Content of Bone to Infection.—Marrow-containing bone, that is, mesenchymal bone with an endothelial content—such as the base of the sphenoid and a growing petrous apex—reacts by elements (reticulum, histiocytes and wandering macrophages) present in the marrow itself.

Surgical Considerations of Infections of Marrow-Containing Bone.—Direct Control of Infection: Thus, the reaction against bacterial infection in marrow-containing bone is a direct local process, which is more efficient than the slower one which occurs in pneumatic bone, because the latter is a part of a systemic reaction, for there is evidence that under certain conditions there exists a truly localized form of immunity which is confined to localized areas or cell groups of the body. This localized or tissue immunity is not a desensitization but is of the nature of a cell immunization (Gay [26]).

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25. Meyer, A. L., and Meltzer, S. J.: On Continuous Insufflation Through the Humerus in Fowls, Am. J. Physiol. **40**:126, 1916.

26. Gay, Frederick P.: Local and Tissue Immunity, in Jordan, E. O., and Falk, I. S.: The Newer Knowledge of Bacteriology and Immunology, Chicago, University of Chicago Press, 1928, p. 881.

On the other hand, special-sense meso-ectodermal compact tissue bone, such as the senescent labyrinth capsule or the compact bone of the visual or olfactory domains, does not react directly to infection. This is largely because of absence of both cellular spaces and a blood supply within the bone itself.

The Modification of Somatic Bone Growth in the Formation of Special-Sense and Protective Special-Sense Bones of the Neurocranium.—The bones of the base of the skull, formed by the petrous apexes, the base of the sphenoid and the segmental portion of the occipital bone surrounding the foramen magnum, all spring in the embryo from primordial somatic proliferating cartilage and all contain red bone marrow at birth. Thus, taking proliferating growth in cartilage as a model, life has formed a neurocranial bone by modifications of the progressing stages of somatic bone growth, that is, by adding to, omitting from or combining one or more stages differently.

A special-sense bone grows endochondrally from cartilage by a process similar to that which occurs in the growth of somatic cartilage bone, but during its growth endothelial permeation does not occur, so that a special-sense bone matures during fetal life and at birth is largely senescent bone. It is still a living and not a live bone.

Thus, special-sense bone is formed in fetal life by (*a*) the omission of the stage of endothelial infiltration which develops bone marrow as well as by (*b*) the omission of the process of absorption of the calcified matrix by the peripheral vessels of the periosteal bone, which occurs in the growth of somatic bone and thus enlarges the marrow spaces in centrally growing endochondral somatic bone.

There is complete absence of protoplasmic infiltration in the growth of the neonatal labyrinth, which at birth is composed of full-grown compact tissue bone.

However, the neonatal labyrinth has on its anterior and posterior surfaces peripherally formed bone, which adds growth increments to those parts of the cortex that are situated next to the dura. Peripheral periosteal bone continues to grow around the neonatal labyrinth during the first two years of the infant's life.

Passively protective pneumatic bones of the (*a*) mastoid process and the (*b*) respiratory portion of the nasal capsule increase in size during infancy and early childhood. The primordial bone itself grows in the fetus by combining (*a*) endochondral bone (without marrow) with a layer of (*b*) surface (appositional) bone; between the two strata at birth is placed infantile fat. Fat which in the somatic bones is the terminal stage of endothelial red bone marrow infiltration in the areas of the neurocranium that are to extend by pneumatic growth appears before the completion of proliferative osteogenesis. Thus, the mammal

prepares while in the fetal stage for pneumatized bone growth during infancy by substituting a process which is terminal in the growth of somatic bone.

Passage of Proliferating Growth into a Histogenetic Process for Functional Differentiation as It Occurs Within the Marrow-Containing Bones of the Base of the Skull.—The transition from proliferative osteogenesis of growth into histogenesis by differentiation division for a specific function occurs in the bones which make up the key position of the base of the skull, because they possess specialized attributes, each attribute being an adaptation and a refinement of a differentiation inherent in all somatic skeletal bones.

These potentialities of the protoplasmic red marrow hemocytopoietic mechanism were gradually augmented in the progressive evolution of the vertebrates, in amphibians, which passed from an aqueous medium and became the reptilians of terrestrial life.[27]

The diameter of the base of the mammalian skull expands [28] by the growth of the spheno-occipital basis in conjunction with the growth of the petrous apexes. However, while the morphologic pattern of these three bones which compose the framework of the base of the skull is an adaptation of the spongiose bodies of the ring-shaped vertebrae, the manner of growth of an apex is similar to the growth of the epiphyseal end of the diaphysis of a long bone. The morphologic pattern of the base of the skull of an infant occurs in a simplified form in all the encircling somatic bones, for the bones of the thorax, pelvis and cerebrospinal axis are active organs for the protection of visceral and neural structures, as well as being supporting skeletal bones. All of them are important units of hemocytogenic activity, and this continues throughout life.

Function of the Marrow-Filled Base of the Sphenoid.—The cellular red marrow within the spongiosa of the base of the sphenoid, in addition to its attributes for proliferative osteogenic growth, acts continuously as the chief biocellular nutritional organ of the base of the skull. It is in this capacity that it becomes the active mechanism which protects the base of the brain, especially the pons, against infection.

Thus, surgically the base of the sphenoid should be regarded not simply as a mechanically protecting bone but as a constantly working histogenetic organ for metabolic activity, possessing specific bactericidal properties, although the matrix of the bone does not increase in size

27. Jeans, James: Through Space and Time, London, Cambridge University Press, 1934.

28. Eagleton, W. P.: Unlocking of the Petrous Pyramid for Localized Bulbar (Pontile) Meningitis Secondary to Suppuration of the Petrous Apex, Arch. Otolaryng. **13**:386 (March) 1931.

after the ossification of the occipitosphenoid synchondrosis, which is completed at about the eighteenth year.

The Specific Functional "Differentiation" of the Marrow Within the Base of the Sphenoid.—Thus, the base of the sphenoid has a (*a*) distinctive embryologic structure because of its (*b*) unique position during the growth of the base of the skull, and because of (*c*) its exposure during life to infective organisms from the upper respiratory tract. Its protoplasmic growth potentialities dictate the (1) distinctive pathognomonic character of the infective lesions that may occur in the marrow of the sphenoid bone, and furnishes its (2) phenomenal osteogenic powers of repair.

Sinusoidal Epithelial Reticulum of the Bone Marrow.—The endothelium of the sinusoidal spaces within the reticulum of bone marrow is functionally and morphologically different from the "surface endothelium" that lines the blood vessels, although sinusoidal spaces empty into the capillaries of the circulatory system. The character of the endothelial sinusoidal space of the bone marrow changes as soon as it becomes the endothelium of the circulatory capillaries (Minot[29]), which latter cannot generate blood cells, a differentiating function possessed by the sinusoidal endothelial reticulum.

Hemocytogenic Reticulum of the Bone Marrow.—This is a part of the (*a*) reticulo-endothelial system of fixed tissue cells (Aschoff and Kizone). It is well named when it is acting in the development of bone. The system is more appropriately designated (*b*) macrophagic (Metchnikoff and Evans) when it is operating under stress, combating infection and taking part in bone repair, and the (*c*) reticulo-histiocytic (Maximow) system when functioning metabolically, which includes its routine bactericidal activity.

(*a*) Aschoff's reticulo-endothelial system is the generic term for that rudimentary connective tissue network which is scattered so freely throughout the body. But as the morphologic character of its elements is constantly changing—depending on the function that the cells are performing at the particular moment—I would opine that the term "reticulo-endothelium" is descriptive of those morphologic features of its osseous units which are outstanding during the normal successive process in growth, at which time the reticulum and sinusoidal epithelium of red marrow play the chief rôle in proliferative osteogenesis.[30]

(*b*) On the other hand, the term macrophage system (Evans) is descriptive of those large mononuclear cells of the marrow which operate

29. Minot, G. R.: Proc. Boston Soc. Nat. History **29**:185, 1901.

30. Leriche, R., and Policard, A.: Normal and Pathological Physiology of Bone, translated by S. Moore and F. A. Key, St. Louis, C. V. Mosby Company, 1928.

actively and are to be found in large numbers when the bone marrow is reacting under the stress of a locally acting infection or in bone repair, for the large motile mononuclear phagocyte and its progenitor, the fibroblast,[31] both spring from the reticulum of the cellular marrow of bone. They are probably the chief elements which combat all foreign irritants that may invade the base of the sphenoid, for mononuclear phagocytes gather in the medullary tissue during active bone absorption (Shipley [32]) and during infection of the petrous apex and the base of the sphenoid. Furthermore, it has been experimentally demonstrated that the greater the number of mesenchymal mononuclear cells (macrophages) mobilized within a tissue, the greater the local cellular immunity against infection (Gay and Morrison, 1923), and that the very act of phagocytosis by histiocytes and mononuclear cells performs an important rôle (Clark [33]) in the production of immunity.

Surgical Considerations of Infections of Marrow-Containing Bone.—Local Areas of Immunity from Infection: I would suggest, then, that the base of the sphenoid reacts locally to infection in a way analogous to that of other areas which possess specific immunity against certain types of infection, viz., the connective tissue of the skin against anthrax (Besredka [34]), the lining of the serous cavities against streptococci (Guy [26]), the mesenchymal lining of the septal alveoli of the lungs against pneumococci (Fried [35]) and an organized group of histiocytes in the gallbladder (Cooke [36]).

The Potential Activity of a Petrous Apex in Combating Infection: A similar potentiality is inherent within the petrous apex, which, however, is operative only when its spongiosa contains red marrow, for after its marrow becomes acellular fat or its bony laminae are partially converted into air spaces, an apex in order to regain active immunity properties must again become filled with cellular red marrow.

Limitations of Local Protection by Granulation Tissue: It has been established experimentally that while granulation tissue usually resists infection from streptococci through round cell infiltration, in certain areas (such as the pleura), polymorphonuclear leukocytes fail to afford protection, while the histiocytes and

31. "Monocytes, macrophages and fibroblasts are closely related forms. A macrophage is merely a monocyte (large mononuclear leucocyte) in a more active metabolic condition." Carrel, A., and Ebeling, A. H.: Fundamental Properties of Fibroblast and Macrophage, J. Exper. Med. **44**:285 (Sept.) 1926.

32. Shipley, P. G.: Special Cytology, New York, Paul B. Hoeber, Inc., 1928, p. 725.

33. Clark, Ada Ramkey: The Rôle of Clasmatocytes in Protection Against Pneumococcus, Arch. Path. **8**:473 (Sept.) 1929.

34. Besredka, A.: Local Immunization, Baltimore, Williams & Wilkins Company, 1927.

35. Fried, B. M.: Defensive and Metabolic Apparatus of the Lungs, Arch. Path. **6**:1008 (Dec.) 1926; The Origin of the Histiocytes (Macrophages) in Lungs, ibid. **3**:751 (May) 1927; The Lungs and the Macrophagic System, ibid. **17**:76 (Jan.) 1934.

36. Cooke, H. H.: The Reaction to Foreign Material in the Normal and in the Inflamed Gallbladder, Arch. Path. **14**:856 (Dec.) 1932.

macrophages—the large mononuclear group of cells of the mammal—do not furnish immunity to such tissues that normally contain them (Gay and Clark [37]).

(*c*) Finally, the term reticulohistiocytic system (Maximow) well describes the mechanism of the bone marrow while it is carrying on its normal metabolic function, a part of which is phagocytic, in keeping the circulating blood stream purified.

Specific Function of the Base of the Sphenoid for Histogenetic Differentiation Against Infection.—The bony spheno-occipital base is an adaptation of the morphologic structure of the bodies of the vertebrae, the spongiose cavities of which continue filled with red marrow throughout life.

The proliferating somatic cartilage from which springs the base of the sphenoid—the prevertebral, improperly named, segment of Kölliker—is converted into bone early during fetal life. Its red marrow constitutes the chief osteogenic agent for proliferative growth of the base of the skull, in which capacity it acts continuously from the time of the establishment of the cerebral blood circulation during the fourth month of fetal life.

But after birth the red marrow of the sphenoid assumes, in addition, a metabolic function of a specific character, acting now in a routine manner for the local protection of the meningeal mesh which surrounds the base of the brain against infective agents that may enter by the oropharynx.

This osteohematogenic mechanism (to prevent infective agents that may be in the oropharynx from reaching the meninges) is developed during the growth of the infant. It is at this time that the burden of protection of the upper respiratory tract through a process of local immunity is gradually transferred from the primitive lymphatic system in the neck [38] and throat (with its chief visceral organ the spleen), to the circulatory hemic system with its reticulo-endothelial units in the bone marrow, with its main purifying organ the liver, the spleen having become the organ of cell storage and cell death in the hemocytopoietic equilibrium (Krumbhaar [39]). Thus, after the nursing period of life the red marrow of the base of the sphenoid becomes the chief active mechanism of protection to the meso-ectodermal tissues covering the brain.

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37. Gay, F. P., and Clark, A. R.: Further Note on Relative Protection by Polynuclear and Mononuclear Cells in Local Streptococcus Infection, Proc. Soc. Exper. Biol. & Med. **27**:995 (June) 1930.

38. Kingsbury, D. F.: The Development of the Human Pharynx: The Pharyngeal Derivatives, Am. J. Anat. **18**:329, 1915.

39. Krumbhaar, E. B.: Functions of the Spleen, Physiol. Rev. **6**:160, 1926.

SURGICAL CONSIDERATION OF INFECTIONS OF MARROW-CONTAINING BONE.—Absence of Lymphatic Enlargement in Osteomyelitis After Infancy: After early childhood infections within the nasal sinuses (an osteomyelitis of a bone of the skull) are associated with but slight lymphatic enlargement.

The Calcified Matrix and Marrow of the Petrous Apex.—These spring, in the embryo, from proliferating cartilage. The growth process is vegetative osteogenesis for the lateral expansion of the base of the skull. Vegetative osteogenesis of the apexes is completed during the second general "filling-out" cycle in childhood, coincident with the massive pneumatization that begets the sphenoid sinus.

The contour that an apex will assume is dictated before birth. Its calcified matrix and substantia spongiosa both spring from the laterally placed parachordal cartilage, which, unlike the meso-ectodermal neurocartilages from which the protective mastoid and the special-sense labyrinth are developed, is probably of pure mesodermal origin. The conversion of senescent cartilage into bone during fetal life is associated with the intrusion of protoplasmic hemocytopoietic red bone marrow the same as is the process of growth in all somatic spongiose bone.[40]

Proliferative Osteogenesis of the Petrous Apexes.—Likewise, the proliferative osteogenesis of a petrous apex is chiefly due to the biocellular growth mechanism contained within the red marrow of its spongiosa. For the petrous apex at birth is filled with red marrow,[41] which continues as long as its osseous structure is increasing in size, after which the apex becomes senescent bone, containing fat or becoming either partially or completely pneumatized.

Hemocytopoietic Growth in the Petrous Apex.—Thus, during growth the morphologic pattern of an apex is a modification of the active red marrow-filled functioning organ of all spongiose bone, although its mode of growth is that of the epiphyseal end of a metaphysis. For the apexes during infancy and early childhood are among the marrow-containing dynamic growth organs that form the mesial portion of the central domain of the base of the skull.

SURGICAL CONSIDERATION OF INFECTIONS OF MARROW-CONTAINING BONE.—1. Anatomic Types of Osteomyelitic Infections of the Apex During Its Proliferative Stage: During lateral expansion of the cranial cavity a petrous apex has the inherent potentialities both of the spongiose body of a vertebra and of the epiphyseal end—the growing end—of a metaphysis. Consequently, it may be the site of forms of osteomyelitic infection that occur in either (1) the body of a vertebra or (2) an epiphysis of a growing bone. But because of its fixed position the

40. Harris,[11] p. 248.

41. Cunningham, D. J.: Text-Book of Anatomy, ed. 5, Baltimore, William Wood & Company, 1923, p. 290. Van Noorden, W.: Contribution to the Anatomy of the Cartilaginous Base of the Skull in Human Embryos, Arch. f. Anat. u. Entwcklngsgesch. (Anat. Abt.), 1887, p. 241.

petrous apex is largely immune to those types of disease that flower under movement, such as tuberculosis and cancer, which are frequently present in a vertebra on a tubular bone.

Having fulfilled its proliferative function in the growth of the base, an apex becomes a senescent organ, its red marrow turning into acellular fat, after which the apex may be invaded by an overflow pneumatic process, in which both its fat marrow and its bony trabeculae may be absorbed.

2. Types of Lesions in Apex: As long as an apex is fat-filled, any infection within it partakes of the properties of osteomyelitis, but when an apex is fully pneumatized, an apical inflammatory process may assume any of the various types of osteitis so familiar in mastoiditis. However, if there is any fat remaining, infection within an apex is likely to be modified by the primitive marrow-containing nature of the bone (fig. 6).

Acute Septic Osteomyelitis of the Petrous Apex (Accompanied by a Positive Blood Culture) and Its Association with Meningitis from the Infection Passing Through the Dura:[42] Osteomyelitis may be (*a*) hemorrhagic, (*b*) phlegmonous or (*c*) gangrenous in form; (*a*) fulminating, (*b*) subacute, (*c*) resting or (*d*) recrudescent in character, and (*a*) of embolic origin or (*b*) due to an extension of a thrombophlebitis from an adjacent area.

The following varieties may occur:

1. Acute fulminating and invasive osteomyelitis; "acute diffuse hematogenous osteomyelitis" of the petrous apex—an infection of the bone marrow of the sinusoidal spaces of the bone marrow.

2. Localized hematogenous osteomyelitis.

3. Subacute thrombotic (*a*) localized or (*b*) diffuse osteomyelitis. (It may suddenly transmute into type 4.)

4. Fulminating osteomyelitic phlegmon with an associated phlebitic meningitis, either from operative trauma or on the advent of a concomitant infection, especially an angina. Embolic Diffuse Hematogenous Osteomyelitis. The osteomyelitis may be limited to (1) an apex, with an associated (*a*) embolic mastoiditis and (*b*) meningeal irritation, or it may involve (2) both apexes, because the infection is in the sinusoidal spaces of the marrow.

The embolic character of the infection is suggested by early spontaneous rupture of the drum membrane; its meningeal character is suggested by an intermeatal type of facial weakness or by pain behind either eye; the exudate within the pontile cistern can be diagnosed by the absence of, or a great reduction in, the nystagmus induced by turning.

Shortly after invasion of an apex by an embolic hematogenous osteomyelitis, the process is likely to become semiacute, from which it passes into a chronic septic stage of bone infection or becomes quiescent and results in resolution. However, it may recrudesce, especially if the infected blood channels are traumatized by operation or the infection is transmitted by an anginal inflammation.

Recrudescent (Thrombotic) Osteomyelitis: This type is associated with an immediate and continuous infection of the blood stream (positive blood culture) and with a thrombotic meningitis or meningo-encephalitis.

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42. Clinical Types of Apical Suppuration and Associated Osteomyelitic Lesions of the Skull in Relation to Meningitis (Based on 42 Cases of Apical Suppuration and 24 Cases of Sphenoidal Bone Disease Associated with Meningitis), Part of Classification submitted to the American Otological Society at Toronto, Canada, on May 28, 1935.

Associated Osteomyelitic Infection of the Marrow-Filled Bones of the Base of the Skull: The sinusoidal space osteomyelitic phlegmon of the base of the sphenoid causes diffuse embolic foci, with terminal meningitis of the subdural space.

Chronic Necrosing Osteomyelitis of the Base of the Sphenoid: If trauma occurs by operation, it may cause a fulminating meningitis.

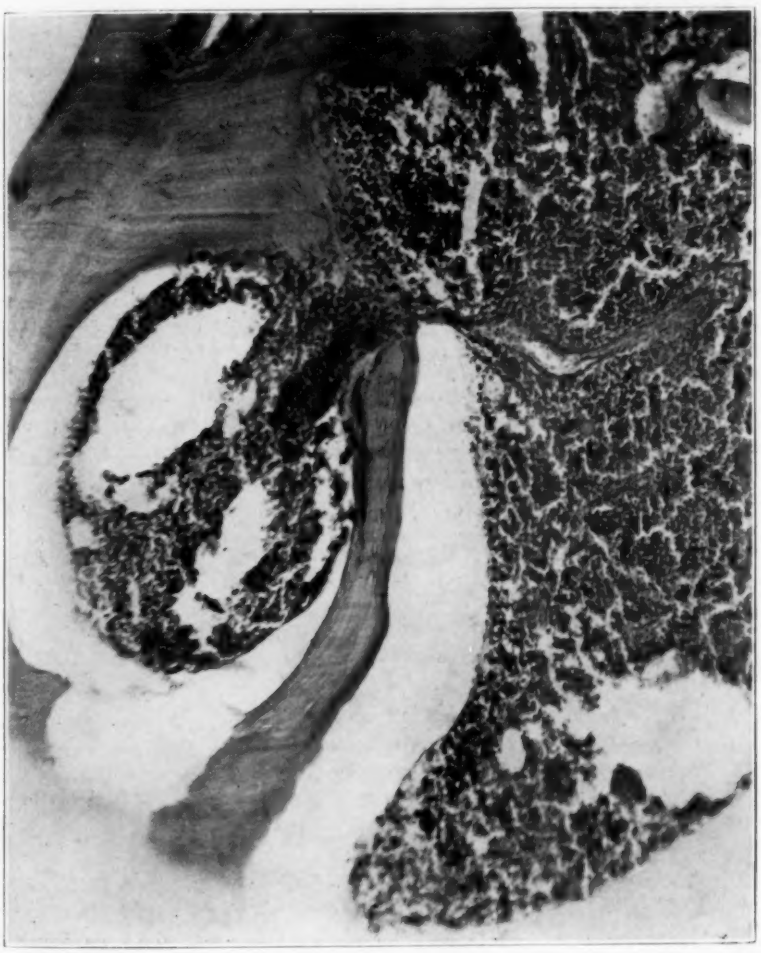

Fig. 6.—Hyperplastic red bone marrow filling the sinusoidal bone spaces in the apex in an attempt to control infection.

The Potential Protective Properties of the Apex on the Approach of Infection.—As long as an apex contains acellular fat, it has the potentiality of metaplasia, that is, of being transformed, under the stimulation of an approaching infection, into its original red marrow state (Custer [19]), in which case the apex again becomes an active bio-

cellular mechanism against infection, a property it possesses in common with all primordial red marrow-filled bones.[43]

Summary of Functional and Structural Potentialities Connected with the Growth of the Petrous Apex.—1. Primarily the petrous apex is made up of a mesodermal bony framework having an endothelial content, modified by its proximity to meso-ectodermal tissues, viz., the special-sense neurocranial labyrinth and the dural envelop of the brain. 2. The endothelial bone marrow within the osseous apex, after serving its vegetative purpose for growth during childhood, becomes senescent, the functioning red marrow being converted into fat. Until acellular fat has replaced cellular red marrow, apical spaces cannot be pneumatized, while any infective inflammation within an apex will partake of the nature of an osteomyelitis. 3. However, all through life any fat marrow that may remain within an apex retains the potentiality of again becoming cellular red bone marrow, under stimulation of infection, which will enable it to regain its original specific bactericidal properties and exceptional reparative powers.

Surgical Consideration of Infections of Marrow-Containing Bones.—Frequency of Spontaneous Cure of Apical Infections: It is because of this potentiality that a local abscess is so infrequent during an apical infection, although a homolateral suppuration of the mastoid is often complicated by a reparative osteomyelitis of the petrous apex. Cure is obtained in fully 80 per cent of all apical infections simply by drainage of the causative suppuration of the mastoid.

Infrequency of Formation of Sequestrums in Cases of Suppurative Lesions Confined to a Petrous Apex or to the Base of the Sphenoid Due to Unique Type of Blood Supply of the Bones Forming the Prechordal and Parachordal Areas of the Base of the Skull: The base of the sphenoid and, to a much lesser degree, the petrous apexes have an adequate blood supply from their own sinusoidal spaces and, in addition, receive blood from independent vascular systems. It is this vascularity that prevents the formation of bony sequestrums in pyogenic lesions limited to a petrous apex or to the base of the sphenoid, in contradistinction to the large sequestrum which forms so quickly and is so frequent in osteomyelitis of a long bone, following an occlusion of its central nutrient "end vessel."

Likewise, in osteomyelitis of the calvarium numerous small sequestrums are common, although they form slowly, because a bone of the cranial vault possesses a central nutrient blood supply inadequate to continue the nutrition of its osseous framework when (*a*) its own nutrient radicles or an (*b*) associated vessel coming from the surrounding soft parts or from the dura is attacked by an advancing thrombosing infective process.

The Relation of Infantile Fat Bone Marrow to Pneumatic Growth.—As previously stated, at birth all the bones of the skeleton have sprung from cartilage and contain red marrow in which there is no microscopically visible fat (Piney[44]), excepting the (*a*) special-sense and

43. Mueller, E. J.: Knochenmark und Leukocyten Beiträge zur pathologischen Anatomie der Leukocytose, Virchows Arch. f. path. Anat. **246**:49, 1923.

44. Piney, A.: The Anatomy of the Bone Marrow, Brit. M. J. **2**:793 (Oct. 28) 1922.

the (*b*) passively protective bones of the skull. Infantile fat, however, fills the bone spaces in the primitive mastoid and in the respiratory portion of the ethmoid labyrinth, both of which areas extend by small cell pneumatization during infancy.

The bone of all protective pneumatic special-sense domains is formed in the embryo by the combination of two osteogenic processes in a manner distinctive for the mammalian cranium. At birth a mastoid or respiratory nasal bone, although it sprang in the fetus from a cartilage anlage and is thus intercartilaginous bone, is covered by a layer of appositional membrane bone, with infantile fat filling in the bony spaces between cartilaginous and appositional bone strata.

Extraterritorial Pneumatization; A Secondary Growth Process.—Other bones in domains which are not the intrinsic sites of pneumatic growth, such as the petrous apex, may become air-filled, but pneumatization can occur only after the internal capacity of the skull is completed and not during the primal formative growth period of the base. Extraterritorial pneumatization is possible only when the regional histogenesis of the bone growth has run its normal course and the red bone marrow of the apex has become converted into fat; that is, the osseous proliferative function—osteogenesis for growth—has passed and the bone become senescent as a growth organ.

Pneumatization of the Petrous Apex.—1. A pneumatic overflow from the mastoid invades the petrous apex in about 35 per cent of Caucasians (Glick[45]). 2. Pneumatization of the petrous apex is an "overflow replacement," not a bone expansion process.

Extraterritorial pneumatization is an overflow replacement, not an expansion growth process. It does not increase the capacity of the skull or the size of its bones. In the mammalian cranium the object of overflow pneumatization is to equalize inequalities between its external and internal surfaces that may have appeared during the growth of the skull.

Overflow pneumatization has a different functional purpose from that of pneumatized growth, although it is a related growth process. Overflow pneumatization occurs at a later period in the growth of the skull, i. e., in childhood, after the size of the apex has been fully determined and the end-organs of hearing and equilibrium have been furnished adequate protection through the completion of lateral expansion of the base of the skull.

Failure of Air-Filled Cells Within a Petrous Apex to Increase the Size of the Bone.—The filling of marrow spaces within an apex by air does not increase the size or alter the external shape of the bone, air spaces lined by most delicate epithelium being substituted for the

45. Glick, N. N.: Microscopic Observation of the Petrous Apex, Ann. Otol., Rhin. & Laryng. **42**:175 (March) 1933.

marrow spaces. This is in contrast to the osteogenesis of the mastoid by pneumatic growth, in which the cortex of the bone is "ballooned" outward, as it were, from the mastoid antrotympanic level.

Surgical Consideration of Infections of Marrow-Containing Bone.—The Influence of Infection on a Partially Pneumatized Apex: Wherever pneumatization extends into an apex, the area pneumatized loses the differentiation potentialities which are inherent within protoplasmic bone marrow. The protective response of the bone now is no longer a locally protective reaction performed by motile histiocytes springing from the sinusoidal endothelial reticulum of the red bone marrow itself, for if a completely pneumatized petrous apex is attacked by infection its protective reaction is through leukocytes and other elements supplied from the general blood circulation. However, when a partially pneumatized petrous apex becomes the site of infection, any bone marrow which lies adjacent to the infected area may completely control the infection within the infected pneumatized spaces, provided the virulence of the infecting organism is not overpowering; that is, surgically speaking, provided the infective process has a tendency to localize and is not actively invasive.

Plasma Cell Mastoiditis Secondary to Infection of the Apex.—A low grade infection in an apex, which is connected by air-filled spaces with the mastoid, may awaken a metaplastic process in the marrow, which may extend externally from the infected apex and result in the filling of the mastoid with plasma cells. An avirulent suppuration of an apex thus gives rise to a specific reparative type of plasma cell mastoiditis.[46]

Surgical Importance of Pneumatization of a Petrous Apex.—Pneumatization of a petrous apex is a different physiologic process from pneumatic growth of the mastoid and occurs at a different stage in the development of the base of the skull. Thus, both the (*a*) period of life during which the spaces in an apex may become filled with air and the (*b*) purpose that pneumatization serves, differ, although the method by which air-filled spaces are substituted for bone marrow is similar in that fat marrow is converted into pneumatic cells by the invasion of rapidly proliferating epithelium.

Fat marrow in an apex, by a process of metaplasia, may again become red marrow and directly control infection.

"Plasma cell mastoiditis" represents a type of reactive protoplasmic protective process which extends into the mastoid cells from an adjacent area that originally contained red bone marrow, whether it is an apex or an occipital bone.

Pneumatization from the apex never invades the base of the sphenoid even under the hyperplastic pneumatization of acromegaly. The red bone marrow is never converted into acellular fat marrow; the base of the sphenoid continues throughout life to be an actively functioning hematogenic organ with inherent bactericidal potentialities, its red bone

46. Eagleton, W. P., in discussion on Vail, H. H.: Vidian Neuralgia, with Special Reference to Eye and Orbital Pain in Suppuration of Petrous Apex (case 2 [W. H.]), Tr. Am. Otol. Soc. **22**:119, 1932.

marrow reacting locally to infection by a protoplasmic growth process and possessing specific properties for repair. Consequently, pyogenic lesions of the base of the sphenoid, because of the bone's (*a*) selective regional position and (*b*) continuous protoplasmic differentiation, are distinctive. Furthermore, an infective disease of the sphenoid sinusoidal spaces runs a different course than does infection of the air spaces of the mastoid or even an infection within a petrous apex.

However, infective lesions of an apex may partake of some of the specific osteomyelitic features seen in pyogenic lesions of the base of the sphenoid or may possess the characteristics of one of various types of infections of pneumatic bone so familiar in mastoiditis.

A coalescing type of inflammation of the petrous apex can occur only when the apex has been invaded by an overflow pneumatizing process during the growth of the base of the skull.

SURGICAL CONSIDERATION OF SPECIAL-SENSE BONES IN GENERAL

Passively Protective Compact (Ebonized) Tissue, Special-Sense Bones.—The special-sense bones (the labyrinth capsule, the perforated plate of the nasal capsule and the mesial area of the orbital roof) never contain any marrow. The osseous growth of a special-sense bone occurs in the fetus from cartilage having membranous (appositional), peripherally formed increments of bone growth. Near the median line area of the anterior two thirds of the cranial base, growth increments from the dura form the internal "investing" layer of the calvarium. Thus, the median domain is composed of both dura and bone, which here become one structure that cannot be surgically divided.

Liquefaction and Absorption of the Compact Special-Sense Bones That Follow Infection.—Special-sense bone, being an inanimate nonvascular osseous structure (the function of which is the passive protection of an end-organ), offers no site in which bacteria can develop or multiply, largely because of lack of protein elements for bacterial food. The liquefaction and necrosis of compact bones are not due to the growth of infecting bacteria within the bone itself but are the result of nutritional death, following the infection of surrounding tissues, which latter furnish the nutritional juices on which both compact tissue and senescent bone live.

Absorption of Dead Bone in General.—Dead bone is removed by the phagocytosis of osteoclasts and mononuclear phagocytes in much the same way that bacteria are digested by means of protoplasmic endothelial elements within the bone marrow, for the endothelial spaces of the reticulum are its functioning part. In it originate the large motile mononuclear cells, which not only are phagocytic but, in addition, are the principal factor in local immunity. Thus, the degree of immunity against infection, or the protoplasmic resistance of individual tissue, is dependent on the number of mesenchymal mononuclear cells present,

for the metabolic action of the red bone marrow is rendered possible by the sinusoidal reticulum within the spongiosa of the base of the sphenoid. Thus, it is the continuous protoplasmic osteogenesis which enables the marrow content to be constantly functioning, giving to the bone its unique reparative and protective properties. It is my contention that the base of the sphenoid, all through life, continues to possess the nutritional circulatory potentialities present in many of the other marrow-filled bones only during the period of their expansive growth.

EMBRYOLOGIC FACTORS AND HISTOLOGIC GROWTH POTENTIALITIES WHICH (1) DICTATE THE FORM AND (2) INFLUENCE THE COURSE OF INFECTIVE LESIONS WITHIN A PETROUS APEX OR OF THE BASE OF THE SPHENOID

There are embryologic and growth factors as well as histologic peculiarities of structures in the bones forming the mesial area of the base of the skull that dictate (*a*) the form that suppurative lesions assume and (*b*) the course that they take.

Functionally, the petrous apexes resemble the epiphyseal end of the metaphysis of a long bone during its growing period, while the base of the sphenoid is a modification of the spongiose body of a spinal vertebra. Both the nutrient supply of the apexes and that of the base of the sphenoid are of the "anastomosing type" (they are not furnished by "end" arteries), and this vascular pattern continues throughout life. Furthermore, the apexes and base of the sphenoid are primarily red marrow containing bones, the active potentialities of which (*a*) are preserved by the base of the sphenoid but (*b*) are lost by the petrous apexes during childhood, after which the cellular marrow of the apex (*a*) becomes fat or (*b*) may be replaced by air-filled spaces. The latter occurs in about 35 per cent of all apexes. However, because of its primitive hemocytogenetic character, those portions of an apex which still contain fat may, on the approach of infection, undergo a rapid metaplastic change, their acellular fat again becoming red bone marrow. Thus a threatened or invaded petrous apex may regain the bactericidal and reparative potentialities which are inherent within the protoplasmic red bone marrow.

CONCLUSIONS

RELATION OF PROTOPLASMIC OSTEOGENIC DIFFERENTIATION WITHIN THE BASE OF THE SPHENOID AND THE PETROUS APEX AND ITS INFLUENCE ON INFECTION

It is the continuation through life of augmented nutritional properties of growth, largely because of their unique blood supplies from bilaterally placed and freely anastomosing vessels, that gives rise to the specialized marrow-containing bones of the base of the skull—the base of the sphenoid and, to a lesser degree, the petrous apexes—and to

their (*a*) distinctive reparative activity as well as (*b*) their specific biochemical resistance against infection. These structures have (1) comparative freedom from infection and (2) specific powers of bone repair; they give a distinctive character to lesions when the structures are attacked by suppuration.

Physiologically Directed Surgical Treatment Necessary for Sinusoidal Osteomyelitis.—Surgical treatment can bring about cure in a considerable proportion of patients with meningitis, but it must be properly directed, for operation on an inflamed vessel in the bone, which vessel passes from the bone into the dura, does either good or harm. There is no such thing as "harmless exploration" in suppurative disease of the base of the skull. Thus the problem of meningitis is a problem of physiology as modified by infection.

PRACTICAL LESSONS

This study of bone embryology and of growth has taught me many things. It has taught me how to recognize the dangerous cases of suppuration of the ear; the cases of apical infection in which operation is required and those in which there should be no surgical trauma, and why Streptococcus mucosus (pneumococcus type III) infection within the ear in an elderly person very frequently causes an explosive terminal meningitis after the ear has ceased to discharge, while infection from Str. mucosus in a child causes mastoditis or at most, sinus thrombosis, which an operation will cure. This study explained many things. It explained the "suspicion of facial palsy which is diagnostic of an advancing lesion within a petrous apex, although no other symptom whatsoever of apical infection may be present."[47] It explained why the turning test is a means of diagnosing an infection localized in the basal system and why the response occurs before alarming signs of meningeal irritation have become evident.[48] But the turning of a patient in whom disease is situated within the small vessels running from the petrous apex into the brain is dangerous, because in a case of infection of the blood vessels, the pial vessels are likely to be softened, in which case turning may upset that delicate balance which exists between the circulatory and the cerebrospinal system, and thus meningo-encephalitis, which is beyond the control of surgical measures, will be precipitated.

Chiefly, this study has taught me how little is really known of suppuration of the bones of the base of the skull and that the treatment of otitic and nasal meningitis today is in its infancy, but like a baby born of healthy and intelligent forebears, has a golden future, perhaps just around the corner.

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47. Eagleton, W. P.: Practical Aids to Diagnosis and in Surgical Management of Meningitis from the Ear or Nose, J. M. Soc. New Jersey **29**:924 (Dec.) 1932.

48. Eagleton,[18] illustration on page 890.

READJUSTMENT OF EQUILIBRIUM FOLLOWING UNILATERAL LABYRINTHECTOMY

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In a previous article [1] the effect of unilateral labyrinthectomy was discussed. The results that we had obtained led us to perform further experiments, especially in regard to the change in the response of the remaining labyrinth over a period of several days. Previous experiments [2] were extended to include the effect of the loss of proprioceptive sensations from one half of the body on the readjustment of equilibrium in labyrinthectomized dogs. And since the cerebellum is regarded as the chief center concerned in unconscious proprioception [3] and is also a highly developed vestibular nucleus, we destroyed part of it and noted the effect of this procedure on the readjustment.

The history of prior discoveries in the physiology and anatomy of the labyrinth is so well known as to require no repetition here. However, one recent anatomic finding will be mentioned. This is the discovery by Steinhausen [4] that the cupola entirely closes the ampullar lumen, thereby making it impossible for even a slight change in pressure in either the canals or the utricle to occur without producing a drifting of the cupola on the crista.

EXPERIMENTAL WORK

In all of our experiments the animals used were dogs which previous to operation were apparently normal. Four experiments were performed.

1. In one normal animal all the canals were tested daily for a period of two weeks, and in five normal animals the horizontal canals were tested daily for ten days.

From the Departments of Otolaryngology, Physiology and Pharmacology, Northwestern University Medical School.

1. Ross, E. L., and Olsen, A.: Effect of Destruction of One Labyrinth on Reactions to Rotation, Arch. Otolaryng. **17**:684 (May) 1933.

2. Ross, E. L.; Fish, M. W., and Olsen, A.: Effects of Some Drugs on the Vestibular Response to Rotation, Arch. Otolaryng. **14**:755 (Dec.) 1931.

3. Ranson, S. W.: The Anatomy of the Nervous System, Philadelphia, W. B. Saunders Company, 1928.

4. Steinhausen: Ueber die Funktion der Cupula in den Bogengangsampullen des Labyrinthes, Ztschr. f. Hals-, Nasen- u. Ohrenh. **34**:201, 1933.

2. In a series of unilaterally labyrinthectomized animals the canals were tested daily, as nearly as possible, for at least two weeks.

3. Similar tests were made daily for at least two weeks on a series of animals each of which had had one or the other posterior column of the spinal cord destroyed and, after a recovery period of two weeks, unilateral labyrinthectomy similar to that performed in experiment 2.

4. Tests were made in a series of animals each of which had had a complete or nearly complete removal of the vermis of the cerebellum and subsequent unilateral labyrinthectomy. These animals were also tested daily for at least two weeks.

The procedures for the labyrinthectomy and the destruction of the posterior column of the spinal cord have been described in previous articles.[5] The approach to the cerebellum was made by separating the cervical muscles from an area on the occiput, extending 2 cm. inferiorly from the occipital protuberance and 5 mm. on each side of the midline. The thin occipital bone was removed from this area with a chisel and rongeur, and the vermis was separated with a sharp knife and removed with a small spoon. There was usually only moderate bleeding. The wound was closed with one mattress suture followed by two or three cutaneous stitches.

The recoveries from this operation were rapid and uneventful. The animals all showed the typical reeling drunken gait associated with cerebellar lesions. A period of at least two weeks was allowed for complete recovery from the operation on the cerebellum or the posterior column before the labyrinthectomy was done. It was found that more or less spontaneous nystagmus was present for three days after labyrinthectomy. Therefore, no rotation tests were recorded till the fourth day after the operation.

OBSERVATIONS

The complete record of the data obtained in this investigation is too extensive for publication at this time. So a summary has been devised in the form of graphs. The purpose of this study is to determine the rate of adjustment of animals after the production of various lesions in their organs of equilibrium. Therefore, our chief concern is the daily change from normal (100 per cent) and not the absolute values of the daily observations.

Curves are plotted for the daily percental average duration of nystagmus resulting from rotation. The percental average is obtained by expressing the average of the daily readings for each animal in percentage of the average for the first three days (taken as 100 per cent) and averaging the daily percental values for all animals in the group to obtain a daily percental average for the group. The purpose of this calculation is to show more truly a group variation when there is a wide difference in the levels of the animals and when it is impossible to have daily data on all the animals throughout a period. Some animals died before the two weeks was over.

Experiment 1.—The effect of repeated rotation of normal dogs was determined from two sets of data. In chart 1, curve *A* represents the

5. Ross and Olsen.[1] Ross, Fish and Olsen.[2]

results obtained by daily rotating five dogs in the plane of the horizontal canals for ten days. The daily rotation of each animal was repeated from three to five times to obtain the average for that day. Rotation was done in this group by electrically driven machinery, resulting in a rotation of the animal about once per second. Curve *B* indicates the results obtained by rotating by hand power one dog in the plane of the horizontal canals at the rate of about 2 revolutions per second; each day's reading was obtained by averaging the results of three test rotations in each direction. The response obtained with the second method was not so constant as that with the first, and the rate was quite different.

The duration of nystagmus resulting from rotation of five normal animals in the horizontal plane from three to five times daily for ten days was practically constant, as observed in chart 1 *A*. In the one normal dog rotated daily for thirteen days by a different method there was a decrease as indicated in chart 1 *B*.

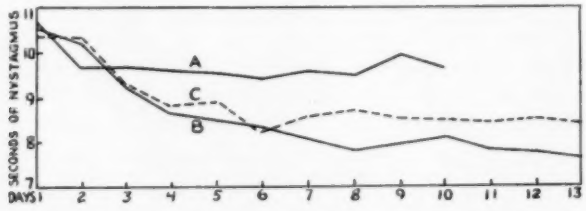

Chart 1.—Normal dogs. Responses to daily rotatory stimulation in: *A*, the horizontal canal, first method of testing; *B*, the horizontal canal, second method; *C*, the vertical canals.

The duration of nystagmus resulting from rotation in the planes of the vertical vestibular canals was obtained by rotating one animal in a mechanical rotator from three to five times daily for thirteen days. The results are recorded in chart 1 *C*. The response to rotation in these canals was more constant than that in the horizontal canals. The curve started at a lower level and ended at one higher than that for the horizontal.

Experiment 2.—The animals with unilateral labyrinthectomies gave different results. The seven animals tested from three to five times daily for fifteen days showed a very slight decrease in the period of nystagmus when the endolymph pressure in the horizontal canal was toward the ampulla (positive pressure, shown in charts by an unbroken line), and a practically constant response when the endolymph pressure in the canal was away from the ampulla (negative pressure, shown in charts by a broken line). When the same animals were tested an equal number of times over the same period for responses to stimu-

lation of the vertical canals, different results were obtained. On referring to chart 2 *B* and *C*, it is observed in general that the response to negative pressure in these canals decreased slightly more than that to positive pressure. It may also be observed that in neither case was the decrease great.

Experiment 3.—The influence of the columns of Gall and Burdach on the irritability of the vestibular apparatus over the period of adjustment after labyrinthectomy was considered worth investigating. Eleven animals were operated on and tested from three to five times daily for

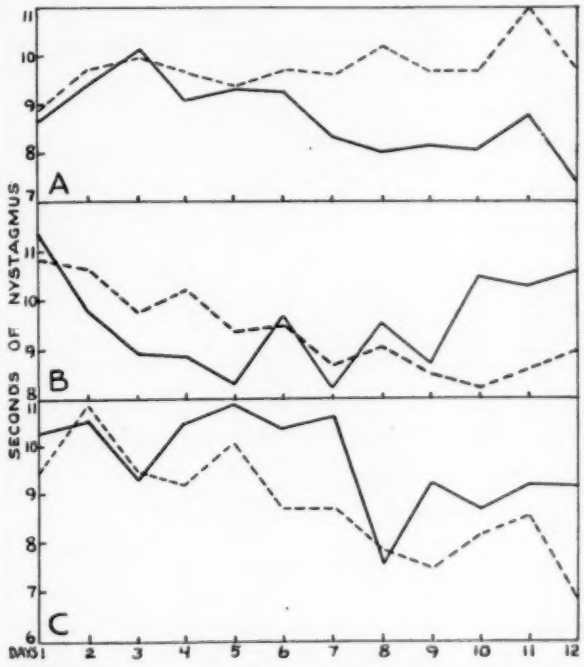

Chart 2.—Dogs on which unilateral labyrinthectomy had been performed. Responses to positive pressure (unbroken line) and to negative pressure (broken line) in: *A*, the horizontal canal; *B*, the anterior vertical canal; *C*, the posterior vertical canal.

about two weeks. On examination of the graphs in charts 3 and 4 no conspicuous and constant changes can be observed. However, the response to positive pressure in the horizontal canal and that to negative pressure in the vertical canals continued to decrease more rapidly than the responses to the other tests.

Experiment 4.—The influence of the vermis of the cerebellum on the adjustment after unilateral labyrinthectomy was of interest since the

cerebellum has to do with equilibrium. The data obtained from six animals over a period of about two weeks are shown in chart 5. A close study of the graphs shows that no influence was exerted by the vermis on the adjustment of the equilibrium except possibly in the case of irritability of the posterior canal when the pressure was negative. The drop in this case was slightly larger than in the other cases. However,

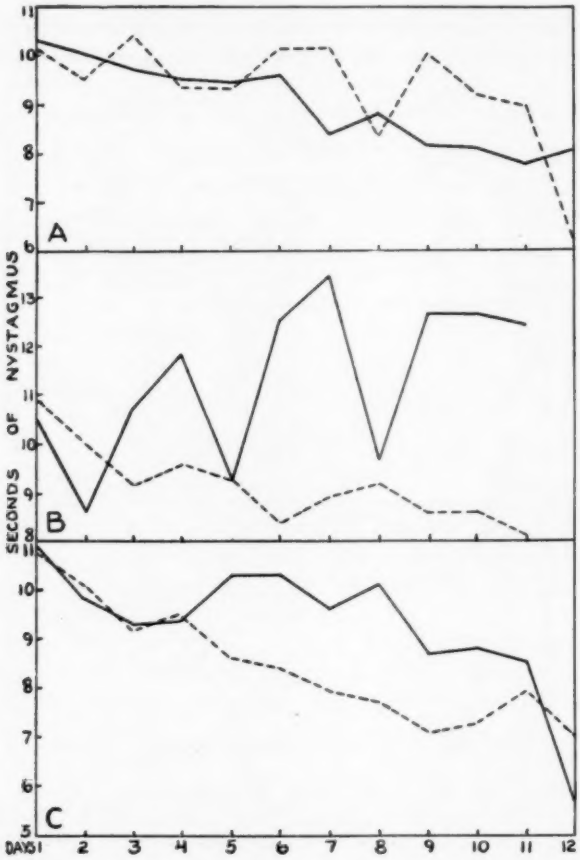

Chart 3.—Dogs in each of which one or the other of the posterior columns of the spinal cord had been destroyed and following recovery a labyrinthectomy performed on the side opposite to the lesion of the cord. Responses to positive pressure (unbroken line) and to negative pressure (broken line) in: *A*, the horizontal canal; *B*, the anterior vertical canal; *C*, the posterior vertical canal on the same side as the lesion of the spinal cord.

in every case the response to positive pressure in the horizontal canal and that to negative pressure in the vertical canals showed the greater decrease during the period of adjustment.

COMMENT

The phenomena appearing after unilateral labyrinthectomy have been known for a long time, and also the fact that some of them are persistent and others transient. It has also been noted from time to time that the abnormal reactions disappear more rapidly and completely in animals that are higher up in the phylogenetic scale. The reasons advanced for this are many, but the one commonly accepted is that there is a center in the brain which exercises control over the labyrinth and that this readily adjusts itself after the disturbance of some part of the system.[6] The exact location of this center has never been definitely

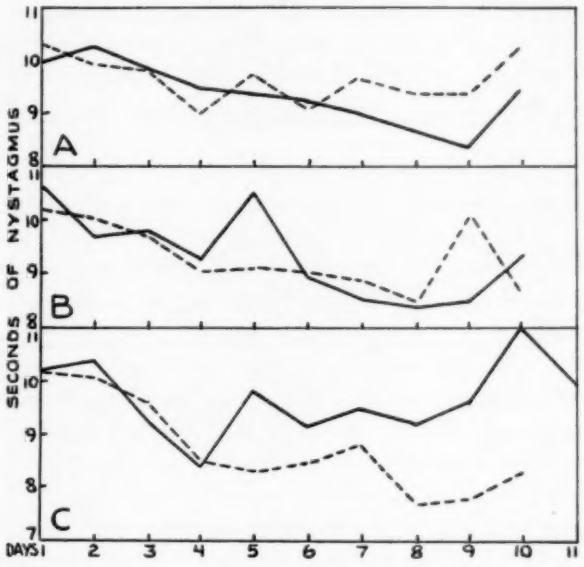

Chart 4.—Dogs in each of which one or the other of the posterior columns of the spinal cord had been destroyed and following recovery a labyrinthectomy performed on the same side as the lesion of the spinal cord. Responses to positive pressure (unbroken line) and to negative pressure (broken line) in: *A*, the horizontal canal; *B*, the anterior vertical canal; *C*, the posterior vertical canal on the side opposite that of the lesion of the spinal cord.

determined. Some insist that it is in the cerebral cortex, citing as evidence [7] the more complete recovery in animals with a more highly developed cortex. Others maintain that it is in the thalamus, the basal

6. Prince: On the Compensation of the Ocular and Equilibrium Disturbances Which Follow Unilateral Removal of the Labyrinth, Proc. Soc. Exper. Biol. & Med. **14**:133, 1916-1917.

7. Camis, M.: Physiology of the Vestibular Apparatus, translated by R. S. Creed, New York, Oxford University Press, 1930, p. 64.

ganglions or the vestibular nuclei of the medulla. According to the work of Griffith [8] and of Maxwell, Burke and Reston,[9] it might be thought that the readjustment occurs by habituation of the labyrinth. These men found that in the white rat and in the rabbit the labyrinth, by repeated stimulation, can be made to lose its sensitivity. Prince [10] found no habituation in the cat. However, he did find that removal

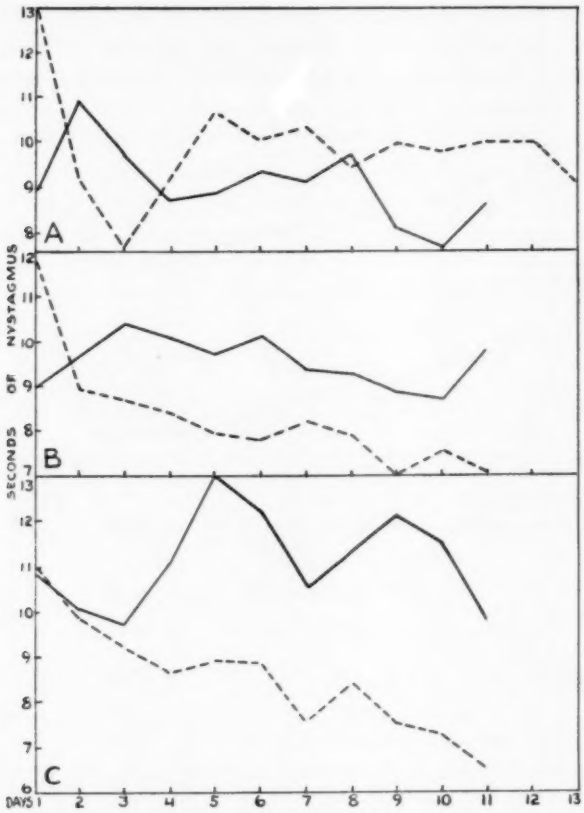

Chart 5.—Dogs each of which had had a complete or nearly complete removal of the vermis of the cerebellum and subsequent unilateral labyrinthectomy. Responses to positive pressure (unbroken line) and negative pressure (broken line) in: *A*, the horizontal canal; *B*, the anterior vertical canal; *C*, the posterior vertical canal.

8. Griffith, C. R.: Concerning the Effect of Repeated Rotations upon Nystagmus, Laryngoscope **30**:22 and 129, 1920.

9. Maxwell, Burke and Reston: Effect of Repeated Rotation on the Duration of After Nystagmus in the Rabbit, Am. J. Physiol. **58**:432, 1921-1922.

10. Prince, A. L.: Observations on the Physiology of the Otic Labyrinth, Proc. Soc. Exper. Biol. & Med. **17**:202, 1919-1920.

of the cerebrum from an animal that had recovered from labyrinthectomy brought about an immediate return of the ocular symptoms. In our work we found that each canal can be stimulated by movement in two directions. Ewald [11] noticed this also but thought that one effect was an inhibition. However, we think both movements are true stimuli since each produces a typical nystagmus, although the response to the movement in one direction is much greater than that to the movement in the other. As already mentioned, we have designated the stimuli as positive and negative pressure on the ampullae; we have found that the vertical canals respond maximally to negative pressure and the horizontal one to positive pressure. The reason for this is not known.

The other finding, that stimulation of the horizontal canal produces a much longer nystagmus, and that this canal is therefore apparently more sensitive to rotation than the vertical canals, may be due to the fact that it is phylogenetically the younger [12] and functionally more useful to terrestrial animals.

Previous investigators have considered the labyrinth of each side as a part of a single organ of proprioception, but our observations have led us to believe that each vestibular apparatus is a functional unit, normally balanced with the other, just as each eye or each arm is. For this reason we believe that when only one organ is present it can function alone and produce all the reactions found when both are intact.

Nystagmus resulting from rotation is the result of an impulse started in the vestibular apparatus which passes to the nuclei of the medulla and thence to the muscles of the eyes. In addition to this well known pathway for these impulses, there is for at least a part of them a passage to the cerebellar cortices and back to the ocular nuclei. The destruction of the endings of the vestibular nerve on one side cannot interfere with the reflex chain of the other side. The structures involved in this reflex arc are: vestibular nerve endings, nerve trunks, medullary nuclei and cerebral and cerebellar cortices. With stimuli remaining the same in number, kind and intensity as had been present throughout life, it is difficult to find a reason for any change in the functioning of nerve endings, trunks or nuclei. The data on the animals with cerebellar lesions show that at least the vermis had no influence on the adjustment. It is well known that impulses coming from the cerebral cortex are influenced by many things. Toxins such as anesthetics, morphine, bromides and many others depress reactions that involve the cerebral cortex. The

11. Ewald, J. R.: Physiologische Untersuchungen über das Endorgan des Nevus octavus, Wiesbaden, J. F. Bergmann, 1892.

12. Stensio, cited by McNally, W. J., and Tait, J.: Some Results of Section of Particular Nerve Branches to the Ampullae of the Four Vertical Semicircular Canals of the Frog, Quart. J. Exper. Physiol. **23**:147, 1933.

presence of other stimuli alter cerebral reflexes; for example, sorrow, joy or fright will reduce the reflexes from pain. In our animals there was a small decrease in the response to rotation on the part of the normal as well as on that of the experimental dogs. There was also a change in the relation of responses from vertical and horizontal canals. These observations lead us to share the opinion of others whom we have cited that the cerebral cortex is the seat of adjustment after a partial destruction of the vestibular apparatus. Lesions in the cerebellum and cord [2] have been proved to alter vestibular responses. Under the conditions of this investigation, these lesions had no influence. Wright [13] states that compensation takes place after cerebellar injury. In all cases of our present series, considerable time elapsed after the lesions of the cerebellum and cord and before the labyrinth was operated on. We believe that cerebral adjustment to these lesions had occurred before the labyrinthine shock was produced.

SUMMARY AND CONCLUSIONS

We have confirmed the observations in previous investigations that destruction of one labyrinth produces a spontaneous nystagmus, horizontal in direction, with its quick component directed toward the normal side, which disappears in from three to four days.

The degree of response to positive and to negative pressure in each canal tended to become equal after one labyrinth was destroyed.

The maximal stimulation of each canal decreased with time, and the response to the minimal stimulation remained relatively unchanged. In other words, the positive stimulation of the horizontal and the negative stimulation of the vertical canals produced decreasing responses as time passed.

The partial destruction of the cerebellar vermis and the cutting of the columns of Gall and Burdach in one side of the cord did not change the adjustment which took place after a labyrinthectomy two weeks or more after the first operation.

The foregoing observations tend to confirm the conclusions of others that the cerebral cortex is a large factor in the readjustment of equilibrium after organic changes in the labyrinth.

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13. Wright, Samson: Applied Physiology, New York, Oxford University Press, 1935, p. 103.

Clinical Notes

OBLIQUE-ANGLED KNIFE FOR RESETTING THE LOWER END OF THE DISLOCATED SEPTAL CARTILAGE AND FOR OPERATIONS FOR CLEFT PALATE AND HARELIP

MYRON METZENBAUM, M.D., CLEVELAND

The oblique-angled knife shown in the illustration is designed for separating the cul-de-sac of the columella posterior-anteriorly for the reception of the lower end of the dislocated septal cartilage in performing my operation for the resetting of the dislocated septum, previously described in the ARCHIVES[1] This knife is further useful in performing operations for cleft palate and harelip, especially for separating the tissues along the edges of the hard palate. The blade is properly angled, and the instrument is well balanced.

Oblique-angled knife used for resetting the septum.

The knife is made by the Storz Instrument Company, 4904 Laclede Avenue, St. Louis.

1. Metzenbaum, Myron: Replacement of the Lower End of the Dislocated Septal Cartilage Versus Submucous Resection of the Dislocated End of the Septal Cartilage, Arch. Otolaryng. **9**:282 (March) 1929.

VASCULAR OCCLUSION OF THE AQUEDUCT OF SYLVIUS

H. A. BEAUDOUX, M.D., OAKLAND, CALIF., AND F. L. REICHERT, M.D., SAN FRANCISCO

A patient with the complaint of a distressing roar in one ear which had been present for more than a year, with recent attacks of headache and occasional spells of vomiting, presented an unusual diagnostic problem.

REPORT OF A CASE

Miss M. B., aged 23, consulted one of us (Dr. Beaudoux) on Oct. 26, 1933, because of a loud blowing sound in her right ear which had not been relieved by tonsillectomy or resection of the septum.

It was reported that at the age of 6 years the patient fell unconscious and struck her head. Three years before she came under observation she was dazed after hitting her head above the right eye. About two years later she was hit between the eyes by an indoor baseball, which stunned her. Three days later she noticed a swishing sound in the right ear; this became louder from day to day and finally was heard faintly in the left ear. The buzzing or roaring noise was present constantly, although it varied in intensity. Friends could hear the noise by placing the ear next to hers. An aneurysmal bruit was heard locally at the sternoclavicular angle; it was not transmitted up the neck or down into the chest. Roentgenograms of the chest and neck showed no abnormalities. Vision and the ocular fundi were normal. Occasionally the patient complained of sensory and motor disturbances which were referable to the fifth nerve. Physical and neurologic examinations otherwise gave negative results.

Several months later the patient experienced slight stiffness of the neck accompanied by headache. During the last months before hospitalization the headaches, in both the occipital and the frontal region, had become more severe, and the patient vomited nearly every day for the two months before admission to the Lane Hospital, on Aug. 21, 1934. Her vision had been blurred for several weeks, and she noticed that the right side of her face was becoming numb, while the intensity of the buzzing in the right ear increased.

When Dr. Emile Holman examined her several months before her admission to the hospital, the buzzing in the right ear was heard as a continuous bruit with systolic accentuation when the examiner's ear was placed close to the patient's right ear. It could also be heard when the stethoscope was placed over the temporal region and could be followed down the neck to the right sternoclavicular region. The bruit was altered when the position of the head was changed, being increased when the head was turned to the left and momentarily stopped when it was bent to the right. It disappeared when the right carotid artery was compressed but was not affected by compression of the left carotid artery. Because there was no exophthalmos and no choking of the optic disk at this time it was believed that the possibility of an arteriovenous fistula between the cavernous sinus and the internal carotid artery could be excluded but that a small opening might be present between the carotid artery and the jugular vein high in the neck.

When the patient entered the hospital the examination revealed little change in the bruit. The patient heard it at times in the left ear. The cardiac sounds were regular and of good quality, and the blood pressure was 135 systolic and 90 diastolic. The lungs, abdomen and extremities revealed no abnormalities. The neurologic examination demonstrated a normal gait, a negative Romberg sign and no ataxia or tremor, although there was subjective dizziness on leaning forward or stooping over. At times lateral nystagmus was noted on looking to the right. The reflexes were hyperactive throughout, except for sluggish abdominal reflexes and absence of the right corneal response. The visual fields were normal. Vision was 20/20 in both eyes. The fundi showed several diopters of choking, with engorgement of the veins. A diminution of sensation to touch and pain was found over the second and third trajectory areas of the right fifth nerve.

and there was corneal anesthesia. There was no weakness of the masseter muscle. A slight impairment of hearing in both ears was detected with the audiometer.

Examinations of the blood gave normal results. The Wassermann reaction of the blood was negative; the urine was normal, and the basal metabolic rate was —5 per cent. Roentgenograms made on Aug. 24, 1934, revealed a definite enlargement of the sella turcica and erosion of the posterior clinoid processes. Both anterior clinoid processes were intact. The digital markings were prominent, indicating increased intracranial pressure. The pineal gland was not calcified.

A diagnosis of an arteriovenous fistula on the right side or, possibly, a tumor of the brain in the region of the right temporal fossa was made because of the bruit and involvement of the right fifth nerve.

A craniotomy was performed on the right side on August 27, tri-bromethanol in amylene hydrate and local anesthesia being used. Trephine openings were first

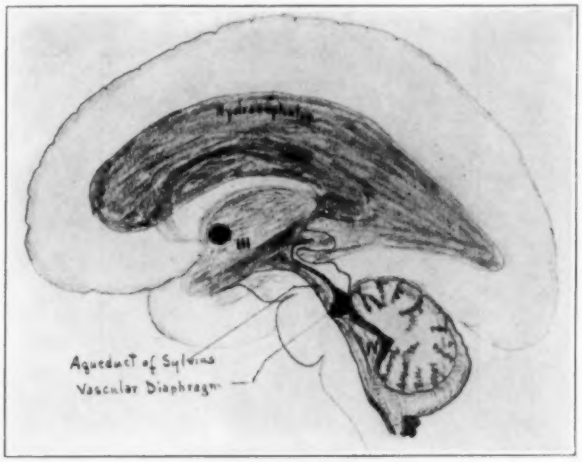

Fig. 1.—Diagram showing the vascular diaphragm which occluded the aqueduct of Sylvius, producing the hydrocephalus which increased the intracranial pressure.

made, and tapping of the lateral ventricles revealed a moderate dilatation, but it was still believed that a bruit on the right side and palsy of the right fifth nerve indicated that the lesion was in the temporal fossa. This fossa was exposed by turning down a flap of bone. When a sterile stethoscope was applied to the cortex no bruit was heard. Further aspirations of the right ventricle permitted easy exposure of the base of the brain. No tumor or fistula was seen, and there was no evidence of pressure on the fifth nerve in this region. An anomalous vein which left the brain and entered the dura under the temporal lobe was coagulated. Closure was effected after a subtemporal decompression was made.

Ventriculograms, made a week later, revealed hydrocephalus with air filling out the third ventricle. This indicated that a block of the cerebrospinal fluid existed in the posterior fossa.

On Sept. 5, 1934, the patient being anesthetized with tri-bromethanol in amylene hydrate supplemented by local anesthesia, the cerebellar region was exposed. A plexus of large vessels, two of which were large anomalous arteries, was found coursing over the vermis. Neutral indigo carmine was introduced

into a lateral ventricle, but no dye appeared in the fourth ventricle, which had been exposed by splitting the vermis and was of normal size. Further division of the vermis revealed a transverse vascular band obstructing the cerebellar end of the aqueduct of Sylvius. This vascular diaphragm was coagulated and severed, the opening thus established permitting the passage of the colored ventricular fluid into the fourth ventricle.

This vascular occlusion of the aqueduct of Sylvius gave rise to the hydrocephalus, which, in turn, apparently angulated the normal basal arteries or the right internal carotid artery in the region of the sella turcica, producing the bruit; but the weakness of the right fifth nerve remained unexplained. The right cerebellopontile angle was explored. No tumor was found, but an irregularity of the occipital bone protruded to touch the right fifth nerve, and it was thought that the increased intracranial pressure produced by the hydrocephalus compressed the nerve against this exostosis.

Fig. 2.—Photograph of the patient taken in July 1935, about one year after the second operation.

Convalescence was uneventful. The sensation in the branches of the right trigeminal nerve had returned to normal within three months after operation, and papilledema had completely subsided. The bruit has not been heard since the second operation. The patient had two convulsive seizures within the first nine months after operation, but she has been entirely well since then.

CONCLUSIONS

A young woman who had suffered several cranial traumas presented herself because of an annoying bruit in her right ear. Under observation this bruit, which was thought to be caused by an intracranial arteriovenous fistula, became more intense, and weakness of the right fifth nerve appeared. This was followed by evidence of developing increased intracranial pressure, namely, headaches, vomiting and papilledema. It was believed that an exploratory craniotomy on the right side was indicated. An arteriovenous fistula or possibly a tumor in the mesial portion of the temporal fossa seemed most likely.

At operation no lesion was encountered to explain the hydrocephalus. Ventriculograms showed that the lateral and third ventricles were dilated.

Two weeks later, at an exploration of the cerebellar region, abnormal vessels on the vermis were found and a vascular diaphragm blocking the aqueduct of Sylvius was coagulated and divided, releasing the obstructed ventricular fluid. An exostosis of the occipital bone pressing against the right trigeminal nerve explained its weakness. The continuous bruit that developed with the hydrocephalus was attributed to angulation of the right cerebral vessels, probably the internal carotid artery.

After the release of the obstructive hydrocephalus by division of the vascular diaphragm at the aqueduct of Sylvius, all symptoms and signs rapidly disappeared, and the patient when seen one and a half years after the operation was in good health.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

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THE PARANASAL SINUSES

SAMUEL SALINGER, M.D.
CHICAGO

The literature on the sinuses for 1935 is voluminous and naturally full of duplications and repetitions. Nevertheless, when one considers the wide territory covered both in the United States and abroad, it is not surprising that similar topics are presented in practically the same way over and over again. The most striking feature of last year's literature has been the definite influence on rhinologic procedure the world over of the work done by Proetz, Hilding, Fenton, Mullin and other Americans. American otolaryngologists have reason to be proud of their work because from every quarter of the globe evidence is accumulating of a keener appreciation of the natural defenses of the sinuses, through which a newer conception of therapy is being developed. I have therefore deemed it important not to overlook any of these reports, because in the aggregate they demonstrate most effectively the trend of the times.

Differences of opinion as to the merits of radical and conservative surgical procedures are still being extensively aired, and it is extremely interesting to note that European otolaryngologists lean rather definitely to conservatism. Witness the discussion on Ferris Smith's paper before the Laryngological Section of the Royal College of Surgeons. It is not unlikely that the indications for radical surgical measures will be more sharply drawn as experiences are reviewed in the light of the newer physiology. Other topics, such as orbital and intracranial complications and tumors, have been thoroughly reviewed in order that the bird's-eye view of the whole subject be as wide as possible.

ANATOMY AND EMBRYOLOGY

Van Gilse[1] describes the development of the neosinus from the paleosinus through the pneumatizing drive of the mucous membrane into the bone. When this pneumatizing tendency in interfered with the

1. Van Gilse, P. H. G.: La lutte pour la place dans le développement des sinus nasaux, Acta oto-laryng. **22**:468, 1935.

bone in the vicinity of the mucosa may yield to the mucosa of a neighboring sinus. The author terms this a "battle for space." Such a combat may take place between the development of the cuspid tooth and that of the antrum. If the sinus develops into the bony area where the apex of the tooth should grow, it will prevent the normal development of the tooth and lead to retention and failure to erupt.

Sitsen's [2] conception of the pneumatization of the sinuses differs entirely from the usually accepted theory, which is based on the inherent power of the mucosa to penetrate embryonic bone. He claims to find no evidence of any pneumatizing influence in the mucosa itself. Even in very young persons this tissue consists of merely a double layer of ciliated epithelium which at no point shows any particular evidence of growth. Neither does the basement membrane show any signs of activity. Sitsen's studies on numerous cadavers at various ages show that the establishment and growth of the frontal sinuses is due to resorption of the spongiosa, and it is his belief that the motive force comes from positive air pressure occurring during the respiratory cycle. Variations in the frontal sinuses are due to varying states of air pressure on the one hand and to the degree of the rate of resorption on the other. Wherever the sinus cavity borders on diploic bone one finds new bony deposits of intervening bony lamellae on the medullary side. This causes the formation of a wall of dense bone which separates the sinus cavity from the spongiosa. Parallel with the absorption of bone for the formation of the sinus cavity there is this formation of new lamellar bone to cover the area absorbed. In very young persons the process of resorption is most active in the dome, and new bone is seen even at this early stage, especially along the rising walls. Later this process is more in evidence, and it is often present in persons of advanced years. This new layer of compact bone always remains thin, being seldom thicker than 200 microns, and it may even undergo resorption in spots. Sitsen finds the maximum development of both sinuses, as determined by the area of the anterior wall, to be 20 sq. cm. On the other hand, entire absence of a sinus may still fall within the classification of normal variability without being considered the result of pathologic arresting influences.

Standenraus [3] believes that the shape of the face is predicated and depends on the embryologic position of the teeth. He stresses the importance of the "opening angle" (*Öffnungswinkel*) of the roots of the teeth. The narrower this angle, the longer the face, and the wider the angle,

2. Sitsen, A. E.: Bau und Entwicklung der Stirnhöhlen, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:79, 1935.

3. Standenraus, J.: Ueber Bau und Entwicklung des Gesichtsschädels mit besonderer Berücksichtigung der Kieferhöhle, Deutsche zahnärtzl. Wchnschr., 1935, p. 871; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:630, 1935.

the broader the face. A wide angle of the roots of the premolars makes possible a deeper location of the remaining tooth buds.

Begara [4] studied a large series of skulls to determine the relationship of the teeth to the maxillary sinuses, and the roentgenograms that he presents help to clarify many of the points brought out in the text. These studies have a practical bearing from the surgical point of view and are worthy of careful examination. The article is too long and detailed for any adequately brief abstract.

An attempt is made by Soldatini [5] to define normal and abnormal sinuses from roentgenograms. According to his criterion, the normal frontal sinus is one with regular outlines and without excentric or walled off portions. The external boundary of the normal frontal sinus is composed of two thirds of the supra-orbital margin, and the superior boundary, of one third of the forehead; there is no extension over the orbit. Normal ethmoid cells should not extend beyond the boundaries of the ethmoid bone. Cells extending upward into the median orbital wall, directly into the frontal sinus or downward into the maxilla are considered abnormal. A normal maxillary sinus should occupy the greater part of the maxilla and should have regular walls and no partitions. In a study of 200 cases the author found the greatest number of abnormalities in the frontal sinus and the least in the maxillary sinus. Also, it is significant that the abnormal sinus is more frequently affected by disease than the normal sinus.

Diploic veins are considered by Wüst [6] to be the carriers of infection in cases of acute osteomyelitis, and he notes that the recent literature has been strangely silent on the point of the presence or frequency of these veins. They have been known since Dupuytren's time and were extensively described by Breschet. The caliber of the venous channels is greater in old than in young persons and is marked by varicose enlargements. The diploic veins may pass across cranial sutures. They are principally without valves and as a rule empty into the cranial venous sinuses or else into the foveolae granulares, where they may anastomose with the vessels of the dura. Wischnewski described a vein frequently found in the frontal bone, which he called norma temporalis. Wüst and Professor Fick, of the Berlin Anatomic Institute, examined 127 macerated skulls and found diploic veins in the frontal bone in all but 21.

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4. Begara, R. A.: Die Kieferhöhle und ihre Beziehungen zur Entwicklung des Zahnsystems: ihre chirurgische Wichtigkeit, Rev. argent. de otol., no. 3, 1934, p. 127; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:522, 1935.

5. Soldatini, V.: Studio radiologico delle malformazioni sinusali fronto-etmoido-mascellari e dei loro rapporti con le sinusiti, Arch. ital. di otol. **47**:349 (May) 1935.

6. Wüst: Demonstration von Röntgenbildern mit Diplovenen im Stirnbein, Ztschr. f. Hals-, Nasen- u. Ohrenh. **38**:188, 1935.

Pancrazi [7] describes a specimen in which the posterior ethmoid cells were enormously developed. They invaded the lateral portions of the sphenoid body, the greater wings of the pterygoid processes and the orbital processes of the bones of the palate.

The ethmoid cells of 5 fetuses observed at 8 months and of 35 observed at term were studied by Jayle,[8] who found two transverse laminae (the anterior and posterior ethmoid laminae) which divided the cells into three spaces. Within the middle meatus there are two secondary laminae, the bullar and the unciform. These divide the middle meatus into three portions: medially, the middle meatus proper and externally the unciform cavity in front of the bullar cavity behind. This arrangement agrees in the main with the conclusions of Mouret, who described in the adult, under the name of laminar roots of the turbinates, the bony plates mentioned by the author.

PHYSIOLOGY

Kerekes [9] conducted some interesting experiments both on human beings and on animals and studied the influence of air currents in the sinuses on the respiratory cycle. He concludes that "the nasal sinuses are organs which by responding to the movements of the air currents reflexly influence the respiratory mechanism. They are reflexly-operating accommodating organs which participate in the automatic function of respiration." The experiments were conducted with a kymograph and a Morey drum. During these tests on the sinuses the respiration was simultaneously recorded by the Gutzman method.

O'Malley [10] presents a long and detailed study of varying air pressures in the nasal cavity and sinuses under normal and pathologic states. He refers to his earlier paper on the subject [11] in which the details of his method are thoroughly explained. He discusses numerous graphs recorded during every phase of respiration, such as normal or forced respiration and respiration during sneezing, hawking, sniffing, etc. The graphs also record the effects of obstruction of the ostium of the sinus and the production of a vacuum, the after-effects of antros-

7. Pancrazi, G.: Nuovo contributo alla conoscenza dell'anormale sviluppo delle cellule etmoidali posteriori, Boll. d. Soc. med.-chir. di Modena **34**:169, 1935.

8. Jayle, G. E.: Note sur les cloisons ethmoïdales du foetus de sept. mois et à terme, Ann. d'anat. path. **12**:876 (July) 1935.

9. Kerekes, G.: Nasennebenhöhlen und Atemmechanismus, Acta oto-laryng. **21**:438, 1935.

10. O'Malley, J. F.: Ventilation of the Nose and Accessory Sinuses: Oscillograph Method of Investigation, J. Laryng. & Otol. **50**:389 (June) 1935.

11. O'Malley, J. F.: Ventilation of Nose and Accessory Sinuses: Oscillographic Method of Investigation, J. Laryng. & Otol. **48**:309 (May) 1933.

tomy and the effects of acute and chronic sinusitis on the air pressure. Some of the points brought out are as follows:

1. Negative pressure of short duration without a corresponding positive phase may occur during quiet respiration. The cycle is restored by forced respiration. This type of pressure is found in association with mild catarrhal conditions and is the earliest evidence of a disturbance in ventilation.

2. Negative pressure followed by delayed positive pressure after several cycles are missed is common in catarrhal conditions and point to the likelihood of a more serious infection.

3. Negative pressure which lasts for several cycles and is not followed by positive pressure on respiratory effort is seen in cases of both acute and chronic suppurative sinusitis. There is usually a return of pressure to normal after several cycles.

4. Sustained negative pressure which lasts for minutes and fails to return to normal is found in cases of chronic infection with polypoid formations.

Among other things, O'Malley states that "the health of the sinus is maintained up to the point at which the positive phases cease to alternate with the negative for several cycles and the ostial barrier causing this is the physical factor which also prevents the outpouring of ciliary activity and is not due to paralysis of the cilia." Also "an antrum with a large patent air opening will remain cured after operation in the absence of infection from without or bone disease from within."

Much of O'Malley's work was corroborated by Carcò,[12] who obtained manometric readings through a traumatic fistula into the frontal sinus of a patient. The variations in pressure were from 2 mm. during quiet respiration up to 30 mm. in forced respiration with the mouth closed. Every physiologic act, such as speaking, laughing, coughing, sneezing or swallowing, was accompanied by a characteristic change in the recordings. The slightest changes in air pressure in the deepest parts of the air passages were accompanied by alterations in the readings from the frontal sinus.

King [13] follows up his work of a year ago in which he demonstrated that the antrum which has been operated on tends to empty through its natural ostium rather than by way of the artificial opening. Two of his original 7 patients in whom the oil failed to move after a long period of observation (ten hours), even though the operation was followed by

12. Carcò, P.: Sulla partecipazione del seno frontale dell'uomo alle modificazioni della meccanica respiratoria, Oto-rino-laring. ital. **5**:110, 1935.

13. King, E.: A Clinical Study of the Functioning of the Maxillary Sinus Mucosa, Tr. Am. Laryng., Rhin. & Otol. Soc. **41**:390, 1935; Ann. Otol., Rhin. & Laryng. **44**:480 (June) 1935.

relief from clinical symptoms and the roentgenograms showed no filling defects, came back for treatment of an acute infection of the antrum which developed after a cold. The author feels that in these cases the infection was dormant and the cilia were inactive because of the latent infection. Other observations showed that the use of strong solutions of silver nitrate in the antrum tended to produce long continued inactivity of the cilia, with consequent susceptibility to colds. King believes that the results of operative procedures may best be appraised by instilling iodized oil into the sinus and watching its expulsion through progressive roentgenograms. Slow or delayed movement of the fluid indicates inactivity of the cilia, which means that the patient is susceptible to reinfection.

Fenton [14] presents an excellent bird's-eye view of physiologic processes involved in the functioning of the mucosa of the nose and sinuses as a barrier against disease. He recounts the recent discoveries and research into the quality of the mucous membrane, its constituent cells and substrata, the influence of various factors on ciliary activity and also the influence of diet, heredity and environment on the development and functions of these tissues. In commenting on roentgen treatment for chronic sinusitis, he states that subsequent operations have shown that the roentgen rays have no bactericidal properties in this connection and that fibrosis furnishes no guarantee against reinfection.

In studying changes of temperature in the sinuses as a result of the local application of heat and cold, Sassosoff and Undritz [15] found that heat penetrates readily into the frontal sinus, causing changes often visible to the naked eye, but works slowly in the antrum and the middle ear. Cold acts more intensely and for a longer period than heat. The authors conclude that the application of heat or cold may be used in a case of infection of the frontal sinus only if agreeable to the patient. Cold may be employed in a case of infection of the antrum only to alleviate acute stormy symptoms, but heat is more agreeable and can be tolerated for a longer period.

PATHOLOGY AND BACTERIOLOGY

Tanturri [16] has for years been of the opinion that trauma at birth or in infancy exerts a retarding influence on the development of the

14. Fenton, R. A.: Recent Discoveries in the Pathology of the Nasal and Aural Mucosa, Canad. M. A. J. **32**:147 (Feb.) 1935; West. J. Surg. **43**:456 (Aug.) 1935.

15. Sassosoff, R. A., and Undritz, U. F.: Zur Frage über Temperaturveränderungen in den Nebenhöhlen und im Mittelohr bei lokaler Kälte-und Wärmeanwendung, Sovet. vestnik. otol., no. 1, 1935, p. 10; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:405, 1935.

16. Tanturri, V.: Sull'influenza dei traumi sulla morfologia naso-sinusale, Rassegna ital. d'ottal. **8**:193, 1935; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:34, 1935.

sinuses. His study of 24 adults and of a number of new-born infants with poorly developed sinuses demonstrated definite degenerative changes in the mucosa and blood vessels, which he attributes to trauma inflicted at birth. In support of his thesis, the author offers a number of experimental studies on animals in which he induced trauma of varying degrees. Although the mucosa showed a remarkable tendency to recover even after severe trauma, he nevertheless demonstrated that extravasation and inflammatory exudate extended into the centers of ossification themselves, where a thinning of the osteoblastic sheet was definitely determined. After three or four months the affected sinus was noticeably underdeveloped as compared with the opposite or central sinus.

On the basis of experimentally induced sinusitis in animals, Linton [17] concludes that purulent sinusitis in human beings depends on the symbiotic action of a filtrable virus plus pathogenic bacteria, the former preparing the field for the reception of the latter. Rabbits were employed for the experiments because of the accessibility of the maxillary sinuses. Emulsions of hemolytic streptococci, Staphylococcus aureus or Staph. albus plus Bacterium leptisepticum alone or with a filtrable virus (vaccination virus), or with this virus plus testicular extract, prepared by the Duran-Reynolds method, were injected into the sinus on one side. Physiologic solution of sodium chloride was injected into the opposite antrum. The results in a large number of animals showed that a combination of bacteria, virus and testicular extract produced almost uniformly a definite purulent sinusitis with the characteristic changes in the mucosa usually associated with this process. The results with bacteria and virus or with virus alone were far less uniform or satisfactory.

Parkinson [18] reports 24 cases of chronic infection of the sinuses in which signs of general toxemia were present. Cultures of material from the sinuses and rectal flora demonstrated more than casual similarity. The author is of the opinion that the intestinal infection was secondary to that of the sinuses and played a major rôle in the subsequent toxemia.

Cameron's [19] observations on the rôle of allergy as a predisposing factor in the development of sinusitis are clinical, supported in part by histologic examination of tissues. He found the chief characteristics of allergic mucosa to be an infiltration with eosinophils and plasma cells, with edema of the matrix. In cases of acute sinusitis the eosinophils

17. Linton, C. S.: Association of Filtrable Virus and Bacteria in the Production of Experimental Sinusitis, Ann. Otol., Rhin. & Laryng. **44**:948 (Dec.) 1935.

18. Parkinson, S. N.: Intestinal Bacterial Flora in Chronic Sinus Disease, Laryngoscope **45**:140 (Feb.) 1935.

19. Cameron, J. A.: An Investigation of the Part Played by Allergy or Sensitization as a Factor in Predisposing the Mucous Membrane of the Nasal Passages and the Paranasal Sinuses to Infection and Its Bearing upon the Treatment of Disease of These Cavities, J. Laryng. & Otol. **50**:493 (July) 1935.

are bilobed, with coarse granules; in cases of chronic sinusitis they are mononuclear with finer granules. The author believes that these cells represent a chemotactic response to allergic stimulus or act as neutralizing agents for substances liberated in the allergic process. He states that "there is no evidence to show that these changes are due to microorganisms," but he feels that allergic manifestations "may have a common genesis in some form of metabolic poisoning which is usually amenable to detoxication." Despite a rather extensive discussion of his observations, the author finds it difficult to determine whether allergy predisposes the mucous membrane to infection.

Buhrmeister [20] studied the chemical content of secretions from the nasal passages of persons with allergic rhinitis and of exudates from persons with maxillary sinusitis and found the following differences: The water and the ash content of the nasal secretion were greater than those of the exudate, whereas the total amount of solids and the protein content of the exudate were three times as great as those of the secretion. The greatest disturbance of the mineral content in the exudate was found in the calcium and the potassium content. The ash content in the extracts of the secretion was found to be much greater than that of the exudate.

McMahon [21] reports on the late changes in the mucosa of the frontal sinuses of dogs after ionization. This article supplements a previous report on the early changes in the same animals.[22] The later study reveals fibrosis of the subepithelial tissues with marked hyperplastic changes in the bone at the end of twelve weeks. There was an eventual transition of the epithelium to a cuboidal type over the areas of greatest destruction. The various steps in the process are shown by photomicrographs of the mucosa of the experimental animals taken at periods of from two to twelve weeks after ionization. The author feels that these same changes taking place in the human nose after ionization, depending on the individual reactions, might lead to permanent atrophy of the glands and symptoms arising from compression of the nerves. It would naturally take some time for such changes to attain their maximum, and the author believes that the result would be a premature "nasopause."

The most frequent site of erosion from disease of the frontal sinus was found by Ohringer [23] to be the orbital wall, with the anterior wall

20. Buhrmeister, C. G.: The Chemical Content of Secretions from Allergic Rhinitis and Sinus Exudates, Laryngoscope **45**:347 (May) 1935.

21. McMahon, B. J.: Late Changes in the Mucosa of the Frontal Sinuses and Nose of Dogs Following Ionization, Arch. Otolaryng. **22**:454 (Oct.) 1935; Ann. Otol., Rhin. & Laryng. **45**:151 (March) 1936.

22. McMahon, B. J.: Effects of Ionization on the Mucosa of the Frontal Sinuses of Dogs, Ann. Otol., Rhin. & Laryng. **43**:643 (Sept.) 1934.

23. Ohringer, J.: Knochendurchbruch nach aussen bei Stirnhöhlenentzündung, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:72 (Oct. 3) 1935.

next in frequency. The reasons are that the orbital wall has numerous preformed channels for vessels and is composed of extremely thin bone. The anterior wall also possesses channels for vessels and in addition is more often the seat of periostitis and rarefying osteitis. Histologic studies showed that infection of the inner mucoperiosteal layer of the anterior wall causes a granulating inflammation to spread into the channels for the vessels, causing numerous microfistulas, which are too small to be visible to the naked eye. The vessels themselves are seldom thrombosed, but their channels are widened through the action of osteoclasts. This accounts for the presence of a subperiosteal abscess in the absence of visible fistulas. The author presents histologic sections to prove his contentions. Small fistulas are seen through the entire thickness of the bony plate, the channels for the vessels being enlarged through resorption and their lumens being filled with granulation tissue surrounding the vessels.

Bossalino [24] reports a case of congenital absence of abduction of the left eye associated with paresis of the right superior oblique muscle occurring in a child of 7 years together with complete absence of both frontal sinuses and an intercurrent chronic associated suppurative otitis media. In discussing the pathologic process, the author expresses the belief that there was no connection between the absence of ocular movements and the condition of the ear. He states that the former was due solely to a disturbance in the muscular system, a true muscular dystrophy.

Becco and Cini [25] describe 2 cases of frontal sinusitis with severe symptoms in which operation disclosed a bony partition within the sinus which shut off part of the cavity, with which it communicated by way of a small opening. In 1 case the partition was transverse, which is a rare finding. Failure to recognize the anomaly led to the performance of an external radical operation instead of intranasal operation. The authors comment on the necessity of careful roentgenographic control in such cases.

Tilley [26] delivered the Semon lecture for 1934 and chose for his topic the pathologic aspect of chronic pyogenic infections of the sinuses. He discusses 5 types of disease, the edematous, infiltrative, fibrotic and cystic types and the type in which the periosteum is involved and the infection passes by way of vascular channels into the bone itself. He

24. Bossalino, G.: Assenza congenita monoculare del movimento di lateralita. associata a paresi del m. retto superiore del lato opposto, e agenesia dei seni frontali, Riv. oto-neuro-oftal. **11**:679 (Nov.-Dec.) 1934.

25. Becco, R., and Cini, C.: Sinusitis frontales con senos tabicados, Rev. Asoc. med. argent. **49**:18 (Jan.) 1935.

26. Tilley, H.: Chronic Pyogenic Inflammation of the Antrum and Other Accessory Sinuses, J. Laryng. & Otol. **50**:1 (Jan.) 1935.

believes that many cases of this last type are overlooked and represent the cases in which recurrence of symptoms follows even radical operation. This residual infection of the bone or "silent osteitis," as he calls it, is characterized by spontaneous local pain and frequently by local tenderness. Diffuse thickening of the alveoli is found in the cases in which the condition follows dental infection. Histologic examination of the bone in such cases shows not only involvement of the osseous tissue but micro-organisms deep within the bone. When the lining of the antrum is removed the bone should be carefully examined for pinpoint collections of pus, which, when followed up, may lead to the infective foci within the bone.

An analysis of the results of 708 Caldwell-Luc operations from the records of the Ear, Nose and Throat Clinic of Leipzig by Schubert [27] revealed only 187 cases in which some complication did not arise. There was only 1 case of meningitis, which, incidentally, was fatal, and only 1 case of sepsis. The remainder of the complications were not of a serious nature, such as fever, swelling of the cheek, angina, infections of the middle ear and hemorrhage.

Leite [28] reports a case of sinusitis in a man of 30 who had an inflammatory swelling about the lateral superior incisor. The tooth was extracted, after which there was a persistent purulent discharge from the socket. Fluid which was injected failed to appear in the nose. Puncture of the sinus gave negative results. Roentgenograms revealed an oval cavity in connection with the alveolar canal of the incisor. A Caldwell-Luc operation demonstrated that the antrum was normal. A probe passed into the abscess cavity failed to find any communication with the antrum but entered an accessory sinus alongside the antrum, from which it was separated by a thin bony wall. The mucous membrane lining this sinus was polypoid, and the cavity contained pus. The condition was differentiated from dentigerous cyst by the presence of the mucous membrane lining.

Fornari [29] contributes 2 articles on the differentiation between Citelli's tumor and the true choanal polyp, as described by Killian. Objectively the tumors are alike, but their genesis is different, as can

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27. Schubert, A.: Verwicklungen im Gefolge von Kieferhöhlen Operation nach Luc-Caldwell zusammengestellt nach Krankenblättern der Universität Ohren, Nasen und Halsklinik Leipzig ans den Jahren 1924-1933, Inaug. Dissert., Leipzig, 1935.

28. Leite, A. O.: Seios maxilares duplos: Um caso raro de sinusite em um seio anormal do maxilar superior, Rev. oto-laring. de São Paulo **2**:393 (Sept.-Oct.) 1934.

29. Fornari, G.: Contributo allo studio del prolasso della mucosa dei seni paranasali, Riforma med. **51**:87 (Jan. 19) 1935; Nuovo contributo allo studio della patogenesi del prolasso della mucosa del seno mascellare, Boll. d. mal. d. orecchio, d. gola, d. naso **53**:505, 1935.

be proved by histologic examination. The author demonstrated on cadavers that the mucosa of the posterior and orbital walls of the antrum is more easily stripped than that of the other walls. Prolapse of this mucosa and extrusion through the ostium would give rise to a tumor held fast by the adherent mucosa on the nasal wall of the antrum. Removal of such a tumor is accompanied by a discharge of cystic yellowish fluid. Section discloses that the mass is lined by connective tissue and covered by cylindric epithelium, showing that the cyst is an inverted pouch of mucous membrane. This is the true Citelli tumor. Choanal polyp, as first described by Killian, on the contrary is solid and reveals a typical edematous fibromatous structure covered by a thin layer of cylindric epithelium and containing few cystic spaces. The author believes that the Citelli tumor is more common than the polyp described by Killian, as he found the latter only once in a series of 8 cases.

A comprehensive study of nasal polypi is presented by Leroux,[30] who divides them into 4 types: (1) solitary sinus polyp, (2) primary ethmoid polyp, (3) diffuse sinus-ethmoid polyp and (4) deforming polyp of the young. Type 1 is generally known as a Killian polyp or a solitary choanal polyp. It is unilateral and pedunculated and as a rule arises from the antrum by way of the middle meatus. It frequently gives one the impression of acute inflammatory edema of the mucosa. The polypi of type 2 arise from the middle turbinate and vary considerably in size. They are usually unilateral. Removal followed by cauterization as a rule effects a cure. The polypi of type 3 are divided into two classes: those arising from the ethmoid cells and those originating from other sinuses. They are usually multiple and are accompanied by evidences of catarrhal inflammation. Diagnosis as to the origin is made by means of roentgenograms and the use of contrast mediums. Therapy depends on the indications. The polypi of type 4 are characterized by widening of the entire nasal structure. Numerous polypi are found arising from all points within the nasal chambers, even including the septum. There is a marked tendency to recurrence after removal, which disappears only after the patient reaches maturity. Nothing new is offered as to the etiology or the pathology. The author notes an increase in the number of eosinophils in cases in which asthma is present. He advises radical surgical intervention, including thorough curettage of the affected sinus mucosa.

In an attempt to solve the problem of the genesis of polypi, Castelfranco [31] presents the results of a histologic study made in several cases

30. Leroux, L.: Les polypes des fosses nasales et sinus, Oto-rhino-laryng. internat. **19**:257 (May) 1935.

31. Castelfranco, U.: Contributo allo studio delle etmoiditi produttive, Boll. d. Soc. med.-chir. di Modena **34**:379, 1935.

of "productive ethmoiditis" in which operation had been performed. He reviews numerous theories of the past and claims that the majority of authors feel that nasal polypi have their origin in inflammatory processes of the ethmoid sinus, which may be limited to the mucosa or may invade the periosteum and bone. Nothing new is offered except the author's personal opinion that polypi represent a reaction to a long continued irritation.

Porta [32] cites an instance in which a patient had been operated on twice for an infection of the frontal sinus and returned a third time with renewed symptoms. Roentgen examination revealed markedly developed cells about the bulla ethmoidalis and an unusually large fronto-ethmoid development. Secondary involvement of the latter was due to invasion through the thin bony plate separating them from the frontal sinus proper. A Skillern operation was performed, with complete relief from symptoms. The author points out that recurrences could have been avoided in the first place had adequate roentgenograms been made.

Som [33] reports a rare case of sphenoiditis in a woman of 25 which began as an acute infection of the upper respiratory tract. Diagnosis of acute sphenoiditis was made on the basis of the roentgen and local examinations. Irrigation of the sphenoid sinuses failed to relieve the symptoms, which became threatening. As symptoms of meningitis developed, the sphenoid sinuses were opened intranasally. The meningitis was superimposed on an abscess of the temporal lobe. Operation revealed disorganized brain tissue with droplets of pus. Autopsy disclosed multiple abscesses of the lungs, diffuse purulent meningitis and an abscess of the left temporal lobe at the anterior pole. Another abscess was found in the frontal lobe. Actinomycotic colonies were demonstrated in the sphenoid sinuses and the abscesses of the brain. None were present in the lungs. The portal of entry for the fungi was not determined.

DIAGNOSIS

Wherry [34] divides the subject of diagnosis into three separate phases: (1) identification of the pathologic process, (2) the "measure of the infection load" and (3) the patient. Under the first heading he emphasizes the need for a complete understanding of the degree and the type of the pathologic process present. He discusses some of the pathologic

32. Porta, C. F.: Sinusite fronto-etmoidale in soggetto con rare anomalie dell' etmoide, Boll. d. mal. d. orecchio, d. gola, d. naso **53**:408 (Aug.) 1935.

33. Som, M. L.: Actinomycosis of the Sphenoid with Actinomycotic Meningitis and Brain Abscess, Ann. Otol., Rhin. & Laryng. **44**:973 (Dec.) 1935.

34. Wherry, W. P.: The Nasal Accessory Sinuses as a Focus of Infection: Evaluation of Various Diagnostic Methods, Tr. Am. Laryng., Rhin. & Otol. Soc. **41**:71, 1935.

changes and the reaction of tissue to infection in the light of recent experimental work and points out the importance of properly appraising such changes before deciding on a line of treatment. The usual methods of diagnosis are taken up and given a practical and reasonable evaluation.

By "measure of the infection load" the author refers to the reaction of the patient to the local pathologic process and alludes in a measure to what is often termed the "focal infection problem." Surgical treatment must be based not only on the extent of the local pathologic process but on the degree of general resistance and on the effects of the local process on the general economy and various remote tissues.

Under the third heading, Wherry discusses the influence of the patient's temperament and psychic make-up on the course and outcome of the infection. He insists that the physician must appraise his patient adequately and learn to measure his treatment accordingly. In other words, the proportions of physical, surgical and mental treatment required will vary among patients according to their psychic make-up as well as to the degree of the local process.

Oaks, Merrill and Oaks [35] emphasize the general status of the patient in the diagnosis of disease of the sinuses. The influence of the endocrine system is illustrated by the following symptoms. Hyperthyroidism causes intense redness and swelling of the intranasal mucosa. Hypothyroidism causes "pale, wet, swollen, sluggish membranes with clinging threads and flecks of what appears to be mucopus." Nasal stoppage is a frequent symptom in the latter part of pregnancy. Overwork, fatigue and lack of fresh air and exercise may cause symptoms mistaken for true sinus disease. The authors believe that Jarvis' work has much merit and are convinced that nasal symptoms may result from imbalance in alkali and acid content of body fluids. They believe also that the study of bacteriology of the sinus may ultimately prove characteristic bacteria for these areas. Among other findings, they report that 234 of 475 patients had sterile maxillary sinuses when examined for supposed disease.

A large number of articles on the roentgenographic interpretation of sinus disease have appeared, many of which merely restate old and generally accepted principles. Here and there, however, one may find a helpful hint which may clarify an obscure problem. Law [36] advises stereoscopic films taken in the verticomental position for visualization of the sphenoid sinuses. He is opposed to the use of the Potter-Bucky diaphragm except for the determination of anatomy. Although this

35. Oaks, L. W.; Merrill, H. G., and Oaks, L. E.: Some Improvements in Sinus Diagnosis, Laryngoscope **45**:198 (March) 1935.

36. Law, F. M.: Causes of Faulty Interpretation of Roentgenograms of the Sinuses, Arch. Otolaryng. **22**:435 (Oct.) 1935.

method yields an excellent picture, it often masks a mild inflammatory process and frequently causes distortion of fine bony lines. The time of exposure must be guided by the gross density of the films. "Too thin a film will produce the appearance of a greater amount of opacity in a sinus and too great an exposure will produce the appearance of a less involved sinus." Pictures of the sinus in the upright position will show a level of fluid in the antrums but may mask the presence of granulations and polypi on the floors. Errors due to differences in the density of the occipital bone and to the presence of a posterior fissure may be overcome by using stereoscopic views. Law advocates that the pictures be made in the oblique position with the patient in the Waters' position to picture properly small frontal sinuses, the outline of which may be lost as a result of severe involvement.

Huber [37] describes a combination head rest and metal mask by which it is possible to take stereoscopic views of the sinuses in four different projections on two 10 by 12 films. The angle of the tube remains constant, and the different exposures are obtained by adjusting the patient's head. The metal mask has four apertures, which are used successively.

The author claims simplification and economy of time and apparatus as well as condensation of technic. Also there is a great advantage in simultaneous study of stereoscopic projections in the four positions.

Ferguson [38] has a head rest for taking stereoroentgenograms in the Granger position by which it is possible to take both pictures without moving the head or disturbing the line of focus. The holder is adjustable, the films are easily changed and the markers may be moved to correspond with the films so that they face the right way and eliminate any chance of error in reading the films.

Cocchiarole [39] presents a lengthy article on the various technics of roentgen examination of the sinuses and interpretation of films. He stresses particularly the value of a horizontal beam in differentiating fluid from hyperplastic membrane or tumor formation and recommends it as superior to the vertical beam in every respect.

Palmer [40] favors the Rhese position for studying the ethmoid and sphenoid sinuses and usually takes stereoroentgenograms. In a series of 500 cases in which this method was used the author studied speci-

37. Huber, P.: Simultaneous Stereoscopic Study of the Nasal Accessory Sinuses, Am. J. Roentgenol. **33**:410 (March) 1935.

38. Ferguson, J. W.: Stereoscopic Roentgenograms of the Sphenoid Sinuses, Arch. Otolaryng. **22**:482 (Oct.) 1935.

39. Cocchiarole, G.: L'esame radiografico del seno mascellare. Importanza e valutazione critica dei varii metodi d'indagine al controllo clinico e chirurgico, Ann. di laring., otol. **35**:127, 1935.

40. Palmer, D. L.: Observations of the Roentgen Pathology of Ethmoid Labyrinth and Sphenoid Sinuses, Am. J. Roentgenol. **34**:181 (Aug.) 1935.

mens removed by the surgeon and then reviewed the pictures in the light of the pathologic changes thus disclosed. He finds that it is important to study details of structure in the films rather than the degree of density. Acute infection shows a gray homogeneous density with obliteration of the sharp trabeculae. This is due to exudate, cellular infiltration and desquamated epithelium filling the cavities. In cases of subacute infection with organization of exudate the picture showed blurred intercellular trabeculae with increased density. Polypoid thickening is frequently made out in the pictures. Many instructive examples are shown.

Granger [41] claims that the 107 degree Granger position yielded him 90 per cent positive results and was much superior to the mentovertex position. Its value lies in the identification of the Granger line, which in all cases of suppuration or a hyperplastic state is obliterated or blurred. Even a small amount of pus served to blur this line. A picture taken immediately after the removal of this secretion always revealed the clear Granger line again. The author also points out that in occlusion of the nose by carcinoma, extensive polyposis or large turbinate bones the mentovertex position might lead to error in diagnosis because of the overlying shadows caused by these masses. Such an error could never occur in pictures taken in the Granger position. The line here is always distinct. Koch,[42] on the other hand, is well satisfied with the verticomental position, which he has found adequate for the projection of all the sinuses without overlying shadows. He props the patient's mouth wide open with a cork and shoots the central ray through the vertex toward the open mouth at an angle of 25 degrees from the vertical cranialward. The patient's chin rests on a plate carrier set at an angle of 23 degrees to the horizontal, the head being fixed between the plate and the tube carrier. Koch admits, however, that there are special instances in which it is advisable to study the sinuses from other angles.

Goss [43] likes the verticomental position for the average patient. However, for stout patients and those who have to be photographed on a stretcher he favors the mentovertex projection. "If the patient is ambulatory, this projection can be carried out with the patient sitting in a chair and leaning backwards with his vertex in contact with the Potter-Bucky." The disadvantages of the open mouth technic are, first, the necessity for the use of a mouth gag and, second, the limited area available for demonstration of the sphenoid sinuses except in edentulous patients.

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41. Granger, A.: One Thousand Sphenoids Examined in Both the Granger and Mento-Vertex Positions, Radiology **24**:357 (March) 1935.

42. Koch, C. E.: Darstellung der Nasennebenhöhlen einschliesslich Keilbeinhöhle auf einer Uebersichtsaufnahme, Röntgenpraxis **7**:259 (April) 1935.

43. Goss, E. O.: A Comparison of the Different Methods of Projecting the Sphenoidal Sinuses, Radiography **1**:49 (May) 1935.

Mittermaier,[44] on the basis of a proved case of intrasellar tumor (acromegaly), disputes the dictum of Stenvers that such a tumor causes the floor of the sella to appear parallel to the floor of the sphenoid sinus, as shown by roentgenograms. Stenvers claimed that a differential diagnosis could be made between primary and secondary widening by the presence or absence of parallelism of the superior and inferior walls of the sphenoid sinus.

Ratti[45] calls attention to roentgenographic aspects of malignant tumor of the maxillary sinus and points out the two essentials for a thorough study of cases of such a tumor: (1) evaluation of the changes in the transparency of the sinus due to the growth and (2) appraisal of changes to be noted in the bony walls of the sinus. While the former may only lead one to suspect the presence of a tumor, the latter is of highest importance in actually diagnosing it. Roentgenographic evidence of involvement of the bony walls can be seen in all but the earliest stages and may prove of great value in determining the type of treatment to be instituted. Among the various projections described by the author there is a new one, a diagonal oblique projection similar to that used by Stenvers, which is useful in demonstrating the posterior portion of the antrum in profile.

Moore[46] does not consider roentgenograms successful unless one can give a definite opinion as to the nature of the mucous membrane. Cysts and polypi may be easily diagnosed without the use of contrast mediums, and frequently they may be differentiated from each other. He cautions against operating on sinuses for polypi that are diagnosed only roentgenographically unless allergy and an acute infection, if present, have been cured. These growths may rapidly disappear if the allergic factor is removed.

Cross[47] states that roentgenologists are frequently blamed for faulty diagnoses by the surgeon who operated some time after the roentgenograms were taken and found a pathologic process differing from that which was originally seen in the picture. The time element is of great importance, as shown in a case in which the roentgenogram disclosed

44. Mittermaier, R.: Inwieweit können Formveränderungen der Keilbeinhöhlen bei der Röntgendiagnostik endokranieller Geschwülste verwertet werden? Röntgenpraxis **7**:513 (Aug.) 1935.

45. Ratti, A.: Contributo radiologico allo studio dei tumori maligni del seno mascellare, Radiol. med. **22**:1 (Jan.) 1935.

46. Moore, C.: X-Ray Diagnosis of Polyps, Cysts and Tumors of the Nasal Sinuses, South. M. J. **28**:456 (May) 1935.

47. Cross, K. S.: The Rapidity with Which Mucosal Changes Can Take Place in the Nasal Accessory Sinuses, Australian & New Zealand J. Surg. **4**:424 (April) 1935.

a definite mucosal swelling with empyema. Seventeen days later these pathologic changes had completely disappeared (spontaneously), as shown in the second picture.

Watson-Williams [48] believes that it is possible to study the contents of any of the sinuses chemically and bacteriologically by injecting sterile water through a fine cannula directly into the openings of the sinuses and then aspirating the resultant mixture. Theoretically this is advisable, but practically it is not always possible, particularly in the frontal and ethmoid sinuses, as all have had occasion to observe.

Van der Hoeven Leonhard [49] seems to think that the anatomic structure and size of the frontal sinus have much to do with the tendency to chronicity in some cases. When the anteroposterior diameter is less than 18 mm., one rarely finds chronic trouble. Sinuses measuring from 18 to 30 mm. are frequently the seat of chronic infection, which can be cured by intranasal enlargement of the nasofrontal duct. When the diameter exceeds 30 mm., the author feels that an external operation is required.

Gittel [50] recommends external puncture of the frontal sinus through its floor for diagnostic purposes but insists that such a procedure must never be undertaken without previous roentgenograms, particularly lateral views. He mentions a fatality due to the instrument's entering the brain in the absence of a frontal sinus.

A transilluminator with two adjustable branches enabling one to illuminate both of the frontal sinuses or antrums at the same time is described by Merelli.[51] The advantages over the older methods are obvious.

Richier [52] goes into great detail describing his experiments with the Proetz displacement technic for diagnosis. He offers the following modifications: the use of 11 per cent iodized poppy-seed oil in preference to the 40 per cent because it flows more readily and still appears radiopaque; hyperextension of the head, beyond the line described by Proetz; the use of not more than 4 cc. of fluid in adults because it is not advisable to fill the cells completely since complete filling obscures

48. Watson-Williams, P.: Remarks on Diagnostic Exploral Suction Sampling of the Paranasal Sinuses, in Kubo, I.: Festschrift zu seinen 60. Geburtstag (26 Dezember 1934) von seinen ausländischen Freunden gewidmet, Tokyo, The Herald Press, Ltd., 1934, p. 21; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:331, 1935.

49. Van der Hoeven Leonhard, J.: Le rôle des éléments stasigènes dans la sinusite frontale, Ann. d'oto-laryng., May 1935, p. 526.

50. Gittel, U.: Zur Frage der Stirnhöhlenpunktion von aussen, Ztschr. f. Laryng., Rhin., Otol. **25**:371, 1935.

51. Merelli, G.: Contributo allo studio ed alla applicazione della diafanoscopia dei seni frontali, Ann. di laring., otol. **34**:99, 1935.

52. Richier, J.: Méthode de déplacement et ethmoïde normal, Ann. d'oto-laryng., April 1935, p. 407.

superimposed images and interferes with proper interpretation, and a pressure not exceeding 18 mm. of mercury for the best penetration of oil into the cells. The author advises the use of the Le Mee apparatus with a mercury manometer. The usual number of aspirations is about 8. The author describes the results in two groups of 5 cases each. In group 1 the technic described by Proetz with 15 aspirations was carried out. Fifteen days later the same patients were tested by the author's method with 6 aspirations. A comparison of the roentgenograms showed that much more fluid entered the cells in the second experiment. In group 2 displacement was performed with 8 aspirations, and roentgenograms were made. Immediately after, fluid was again instilled, and 8 more aspirations were done. In 2 cases the roentgenograms showed no change. In 2 cases the roentgenograms of the sphenoid sinus showed an air bubble in the lower part of the oil. In 1 case the onodi cell, which was perfectly filled at the first displacement, was found to be empty except for a margin of oil after the second instillation. The author advises quick application of the negative pressure at the onset with prompt release of the finger closing the other nostril. The two phases of the displacement are emphasized: first, evacuation of the air from the sinus and, second, the passage of the oil into the evacuated space. Faults of technic, such as having the opening of the aspirating tip directed against the ala or septum, are pointed out, and the influence of nasal obstruction on the success or failure of the test are described.

SINUSITIS IN CHILDREN

Spielberger [53] objects to the preliminary removal of the tonsils and adenoids in the presence of a chronic infection of a sinus. He believes that the procedure aggravates the infection and protracts the course of the disease. His advice is not to operate until the disease is cured or at least is greatly improved. He thinks highly of the use of autogenous vaccines made from the collected secretions from the nose, sinus discharge, tonsil exudate and smears from the pharynx. The initial dose should be small and should be given intramuscularly once a week. Of 44 patients treated with vaccines and other palliative measures, 22 were cured and 18 improved. Where antrotomy is indicated, it is done with the patient under general anesthesia. The use of a preliminary epinephrine pack decreases the amount of bleeding. The opening is made with the author's trocar, and the sinus is inspected through an antroscope. The opening is enlarged either with a rasp or with a Jensen punch. Packings of iodoform gauze are left in the inferior meatus for two days. Suction, tampons of mild protein silver and radiant heat, infra-red rays or ionization are used in the postoperative treatment.

53. Spielberger, W.: Sinusitis in Children: Diagnosis and Treatment; Case Reports, Laryngoscope **45**:114 (Feb.) 1935.

Scantlebury [54] has not found vaccine treatment of much value in his experience. He draws the following picture of chronic sinusitis in children: pale face, nasal discharge, nasal obstruction, frequent colds, loose cough, deficient general development, occasional hoarseness, headache, cervical adenitis and frequent otitis media. He believes that the chief etiologic factors to be lack of vitamin A, excess of starches and meats, lack of calcium, nasal abnormalities, hypertrophied tonsils and adenoids, poor hygiene and undue exposure. The treatment he advocates is along the lines generally followed in this country.

Mitchell's [55] experience has been that diseased sinuses do act as foci of infection and "are responsible for many chronic complications and that often failure to improve after tonsillectomy is attributed to sinuses that were diseased at the time or subsequently became diseased." He is convinced that chronic disease inhibits the development of the sinuses but suggests further that if it is properly treated, even up to the age of 9 years, the sinuses may still grow and become normal.

Despons [56] contributes a lengthy dissertation on sinusitis in children, embracing the development, the relationship to tooth buds, the etiology, the types of infection and the treatment. He recommends the following palliative treatment for acute ethmoiditis: ephedrine, epinephrine, isotonic irrigations, heat, vaccines and simple incision if the abscess points toward the orbit. For acute infection of the maxillary sinus in infants, he prefers sublabial to intranasal drainage. For cases of chronic infection of the antrum he prefers displacement irrigation with isotonic solutions and the administration of vaccines or biochemicals in addition to the usual constitutional treatment. The author believes in early removal of the tonsils and adenoids as an aid to ventilation and drainage.

Cantor [57] found that 65 per cent of his patients in the Melbourne Children's Hospital had some form of sinusitis. Frequent colds in these children were due more often to sinusitis than to hypertrophied tonsils and adenoids. The author finds exploratory puncture of the antrum more reliable for diagnosis than roentgen examination. He is also convinced that in many cases the condition is primarily allergic in origin. Otitis media is frequently found in conjunction with sinusitis, which it often overshadows. The author does not resort to puncture and lavage as frequently as others but relies on the use of mild alkaline douches and tampons soaked in mild protein silver.

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54. Scantlebury, G. C.: Sinusitis in Children, Brit. M. J. **2**:781 (Oct. 26) 1935.

55. Mitchell, E. C.: The Pediatric View of Otolaryngology, J. A. M. A. **105**: 1016 (Sept. 28) 1935.

56. Despons, J.: Les sinusites de l'enfance dans leurs rapports avec la dentition, Rev. de laryng. **56**:986 (Sept.-Oct.) 1935.

57. Cantor, C.: Sinusitis in Children, M. J. Australia **1**:13 (Jan. 5) 1935.

Burman's [58] treatment for acute sinusitis is rather elaborate. He advocates the use of hot foot baths, hot liquids, citrus fruits, powder of ipecac and opium, small doses of atropine on the second day until the throat is dry and salicylates for constitutional symptoms; also ephedrine by the Proetz method, inhalations of steam and the application of radiant heat. Treatment at the office is undertaken as soon as the temperature has been normal for twenty-four hours. This consists of inhalation of a spray of a cocaine and ephedrine solution, suction through a soft catheter and sprays of oil. The general treatment consists of proper diet, hygiene, restriction of salts and the administration of calcium, parathyroid extract and viosterol as well as the use of autogenous vaccines.

Ferris Smith [59] points out the factors causing chronic sinusitis in children, such as allergy, avitaminosis, hypothyroidism and poor hygiene. He believes that treatment with drops into the nose is nonsense and that the only two methods of introducing therapeutic agents are direct injection through a cannula or needle and displacement. He finds general constitutional treatments of highest value in cases of chronic infection.

Chronic infection of the antrums is responsible for many cases of asthma, chronic cough and rheumatism in the opinion of Perry.[60] He believes that the infection is carried to the bronchial and mediastinal glands and quotes Mullin on this subject. Despite the age-old objection to submucous resection in children, the author has performed the operation for the past twenty-five years and has never found that it retarded the development of the nose. He finds no difficulty when it is done with the patient under ether anesthesia administered rectally. He advises that a window be made in the antrum with the patient under general anesthesia and suggests the removal of the anterior end of the inferior turbinate and infraction of the remainder. He makes a large opening with the help of curved saws and a hook which he devised. In the discussion which followed Perry's presentation, most of the comment was unfavorable to such a radical operation, it being claimed that equally good results were being obtained by more moderate procedures.

Hartsook [61] finds chronic sinusitis of low grade to be the cause in many cases of anemia, chronic cough, loss of weight and frequent colds,

58. Burman, H. J.: Sinusitis in Children, Laryngoscope **45**:440 (June) 1935.

59. Smith, Ferris: Chronic Sinusitis in Children, J. Michigan M. Soc. **34**:593 (Oct.) 1935.

60. Perry, R. W.: Wet Antrum in Childhood, Tr. Pacific Coast Oto-Ophth. Soc. **23**:88, 1935.

61. Hartsook, N. E.: Some Diseases Resulting from Obscure Sinusitis and Mastoiditis Which Are Usually Treated by the Family Physician or Pediatrician, J. Tennessee M. A. **28**:252 (June) 1935.

and he has seen cases in which the nasal symptoms were overlooked. He states that "much if not a majority of the pneumonias incident to children properly may be attributed to sinus infection."

Muggia [62] reports a case of purulent maxillary sinusitis in a newborn infant in whom there developed circumscribed osteitis of the floor of the sinus which extended through the palate and general septicemia. A sequestrum which was removed later left a hole measuring 7 by 4 mm., which was repaired after the discharge had ceased. Syphilis was excluded as an etiologic factor, and the author believes that the infection was contracted through nursing a person with suppurative mastitis.

An interesting case of persistent frontal headaches occurring in a child of 12 with symptoms of hypophyseogenital dystrophy is described by Rouèche and Lévy-Deker.[63] Roentgen examination failed to show any change in the sella, and the metabolism, blood and urine were normal. Treatment with endocrine preparations was without effect. A further study of the sinuses revealed cloudiness on one antrum. Lavage through an infraturbinal opening revealed a latent infection, and several treatments sufficed to cure the headaches.

Comby [64] quotes liberally from an article by Munyo and Iglesias Castellanos [65] and gives his impressions after studying 19 cases of acute ethmoiditis thoroughly from every angle, i. e., as to pathogenesis, differential diagnosis and therapy. He stresses the value of conservative treatment and is partial to the use of antivirus, antipyogenic vaccine and bacteriophage and to local applications of cocaine and epinephrine.

Three articles on chronic ethmoiditis in children are contributed by Leroux.[66] He claims that little attention has been paid to this condition and cites a number of cases. In several the ethmoiditis was associated with asthma. Chronic ethmoiditis usually occurs in the second decade in a child whose tonsils and adenoids have been removed and whose chief complaints are frequent colds and nasal obstruction. The etiology is varying. The condition may result from a previous acute coryza, an infectious fever or grip. Usually the child is disposed to allergic manifestations and suffers from dietary deficiencies, recurring adenoids or

62. Muggia, A.: Setticemia del neonato di origine nasale (sinusite mascellare-purulenta), Pediatria **43**:202 (Feb.) 1935.

63. Rouèche and Levy-Deker: Céphalées et sinusite maxillaire latente chez l'enfant, Méd. inf. **42**:44 (Feb.) 1935; Bull. Soc. de pédiat. de Paris **32**:710, 1934.

64. Comby, J.: Les ethmoïdites aiguës infantiles, Arch. de méd. d. enf. **38**:167, 1935.

65. Munyo, J. C., and Iglesias Castellanos, A.: Etmoiditis en el niño, Arch. urug. de med., cir. y especialid. **2**:390 (March) 1933.

66. Leroux, L.: L'ethmoïdite chronique de l'enfant, Méd. inf. **41**:405 (Dec.) 1934; J. de med. de Paris **55**:503 (June 6) 1935; Ann. d'oto-laryng., April 1935, p. 415.

a deviated septum. The most characteristic finding is a pale enlargement of the middle turbinate. Polypi are extremely rare. Frequently there is an associated chronic maxillary sinusitis. The etiologic factors must be taken into consideration in determining the treatment. The author stresses the value of climatic treatment rather than dietetic management, which he claims Americans overemphasize. He also believes that the rôle of vitamins has been exaggerated. Locally he recommends cauterization of the turbinate with chromic acid or removal of its anterior end. When polypi are present, he thinks that it is proper to remove them and to curet the cells. He is opposed to resection of the septum because of the difficulties of doing it under general anesthesia and also because he believes that it may affect the subsequent development of the nose.

SINUSITIS IN RELATION TO DISEASES OF OTHER ORGANS

Hartsook [67] and Owen [68] present excellent discussions of disease of the sinuses from the internist's point of view. Hartsook furnishes a review of the literature on the subject of the relationship of sinusitis to diseases of the eyes and chest, particularly asthma, but offers nothing new. Owen, on the other hand, makes the statement that as a focus of infection the sinuses rank third, being involved less frequently than the teeth and the tonsils. He believes that treatment of the sinuses must rest on their own merits. He does not feel that chronic sinusitis causes inflammatory lesions of the lung parenchyma, the cardiac muscle or the valves or has anything to do with gastric or duodenal ulcer, cholecystitis, appendicitis, ulcerative colitis, nephritis, pyelitis or anemia. His experience with arthritis and sinusitis has been disappointing so far as the results of the removal of foci of infection are concerned. Here again the sinuses must be treated on their own merits. They can be judged only as contributing to the remote lesion rather than as being the direct cause. However, Owen does concede that sinusitis may be the direct cause of a toxic neuritis affecting the third, fourth or sixth nerve. His views on the connection between sinusitis and nontuberculous pulmonary conditions is pessimistic. The generally negative tone of Owen's paper drew a rather spirited rebuttal from Mithoefer, who felt that the essayist had reviewed the problem much too conservatively. His own experience had conclusively demonstrated frequent and definite etiologic connection between chronic sinusitis and diseases of other organs. Mithoefer concedes the necessity of appraising the patient's general condi-

67. Hartsook, N. E.: A Group of Diseases Dependent upon Paranasal Sinusitis as the Cause, J. Tennessee M. A. **28**:32 (Jan.) 1935.

68. Owen, T.: The Relation of Accessory Sinus Infection to General Medicine, Tr. Am. Laryng., Rhin. & Otol. Soc. **41**:81, 1935.

tion before condemning a sinus. Such factors as allergy, intestinal disorders, hypothyroidism and dietary influences must be carefully gone into. The poor results following operations as alluded to by the essayist may have been due to lack of proper attention to these factors.

Pulmonary Disease.—Cooke and Grove [69] studied a series of 248 cases of infective asthma beginning after the age of 10 and found the sinuses to be an etiologic factor in 92 per cent. They believe that "infective asthma is the result of allergic reaction to bacteria or their products." This is evidenced "by the frequency of allergy in the preceding generations, by the associated allergies present, by the eosinophilic response of the membranes of the sinuses, by the condition of the exudate, sputum and blood and lastly by the reproduction of symptomatic asthma, through injections of vaccine." The sinuses were operated on in 120 of their asthmatic patients. Observations for periods of from six months to three and one-half years after operation showed 70 per cent of the patients to be definitely improved. Those patients who were subjected to a radical operative procedure gave a higher percentage of cures than those who were treated more conservatively (86 per cent as against 39 per cent). The most common finding at operation was a hyperplastic mucous membrane. The incidence of polypi was very high, but pyogenic infection was less frequent.

Manges [70] refers to a previous work of his in which roentgen examination of 354 patients with asthma disclosed sinus disease in 60 per cent. Conversely, 85 per cent of patients having sinus disease showed roentgenographic evidences of pulmonary changes. He has lately made it a practice to take pictures of the sinuses of all patients sent to him for study of the lungs in whom there was no evidence of tuberculosis. He has found innumerable instances of sinus disease which was previously unsuspected by either the patient or the physician. Reexamination of a group of patients with pulmonary lesions in whom he had previously found sinus disease the presence of which had not been suspected revealed definitely that after proper treatment there was improvement in the condition of the sinus as well as in the pulmonary process.

Discussing bronchiectasis, Farrell [71] states that of 66 patients whose sinuses were examined roentgenographically, 86 per cent showed evidence of inflammatory change; in 24.2 per cent, the changes were marked.

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69. Cooke, R. A., and Grove, R. C.: Relation of Asthma to Sinusitis, Arch. Int. Med. **56**:779 (Oct.) 1935.

70. Manges, W. F.: Accessory Sinus Infection: Its Relationship to Mastoid and Lung Infections, Ann. Int. Med. **9**:547 (Nov.) 1935.

71. Farrell, J. T., Jr.: The Importance of Early Diagnosis in Bronchiectasis, J. A. M. A. **106**:92 (Jan. 11) 1936.

Hodge [72] presents a review of the history of nontuberculous pulmonary disease in its relationship to sinus infection with copious references to the literature. He believes that the relationship is more frequent than is generally supposed and may date back to childhood. Pulmonary collapse and pneumonitis seen in childhood may so weaken the lungs as to render them favorable mediums for future infections. He also advocates surgical treatment for bronchiectasis after adequate attention to the concurrent sinusitis. In the discussion which followed, Gill pointed out the frequency of sinusitis complicating the infectious diseases of childhood and the fact that these diseases are often overlooked or overshadowed by the concurrent bronchitis. The fact that the onset of the sinusitis and that of the bronchitis are concurrent does not, however, mean that the sinus infection, if left untreated, may be a factor in the prolongation of the pulmonary complaint. Hodge, of the Mayo Clinic, reports a lower incidence of sinusitis complicating bronchitis than have other observers. In a series of 245 consecutive cases he found evidence of sinus disease in only one-third. However, in 50 per cent of the cases in which operation was done for the sinus complaint there was definite clinical improvement observed in the pulmonary condition. Metzenbaum points out the danger to the tooth buds if the Caldwell-Luc operation is done on children and claims that the intranasal operation is adequate in practically all cases.

Kartagener and Ulrich [73] consider the connection between sinusitis and bronchiectasis as occurring in various ways.

1. Occurrence of bronchiectasis after sinusitis
   (*a*) Aspiration of infected secretion
   (*b*) Aspiration of infected tissue
   (*c*) Transmission of infection by way of lymph channels
2. Occurrence of sinusitis after bronchiectasis by extension upward of chronic bronchitis, the infected material being frequently coughed up into the nasopharynx
3. Simultaneous infection of both the bronchi and the sinuses due to exogenous influences (measles, influenza) and parallel development of the mucosal infections

(The author believes that bronchiectasis occurs in patients who are predisposed through congenitally weak bronchial walls.)

4. Congenitally weak and undeveloped sinuses in association with congenitally weak bronchi, which accounts for the parallel development of infections in both places due to the same infective agent

Eighty-six persons with bronchiectasis averaging thirty-three years in duration were studied roentgenographically, and 32 were found to

72. Hodge, G. E.: Relation of Bronchiectasis to Infection of the Paranasal Sinuses, Arch. Otolaryng. **22**:537 (Nov.) 1935.

73. Kartagener, M., and Ulrich, K.: Bronchiektasien und Veränderungen der Nasennebenhöhlen, Beitr. z. Klin. d. Tuberk. **86**:349, 1935.

have chronic maxillary sinusitis. In most of the cases the condition was of the hyperplastic type. In many of the patients the frontal sinuses were absent or underdeveloped. For comparison, 100 patients with a history of previous injury to the head were examined, and only 16 per cent were found to have arrested development of the frontal sinuses as compared to 38.4 per cent in his series of bronchiectatic patients. The author believes that the high percentage of small frontal sinuses was due not to disease of the adjacent maxillary sinuses but to a constitutional endogenous influence, the same that was responsible for the bronchiectasis. He therefore concludes that the frequent occurrence of disease in the two locations is the result of a congenital weakness of the organs themselves.

Mental Disease.—Parfitt [74] cites Graves as reporting an astounding incidence of sinusitis in psychotic persons with striking results after treatment. Of 1,000 patients, 818 had infections and half of this number recovered after treatment. He also quotes Clarke, McCowan and Wright on this aspect. An investigation of many cases and the reports of others leads Parfitt to believe that the treatment of sinus infections cannot be expected to make any material alteration in the progress of manic-depressive or schizophrenic psychosis. Such treatment was of great value in 3 of 26 cases of confusional insanity. The indications for treatment depend on the result of a routine examination of the nose and throat. Positive proof by puncture may not be necessary.

Jacod [75] describes a case in a woman, aged 35, in whom during the course of acute maxillary sinusitis there developed periods of mental confusion and dulness alternating with periods of great agitation and frightful hallucinations. Puncture of the antrum yielded masses of thick, cheesy pus followed by relief from the mental symptoms. Several years later the patient experienced the same symptoms during another attack of acute sinusitis and suffered two more recurrences at yearly intervals. At other times the patient's mental status was normal. The author points out that he was dealing with a different type of mental disturbance from that which accompanies intracranial complications such as meningitis or abscess. He ascribes the manifestations to toxic irritation in a person whose nerve tissue is particularly susceptible.

Ocular and Orbital Disease.—Sargnon [76] has written an instructive and well illustrated article on the relationship between nasal and ocular

74. Parfitt, N.: Sinusitis in Mental Disorder, Lancet **1**:429 (Feb. 23) 1935.

75. Jacod, M.: Confusion mentale aiguë et sinusite maxillaire aiguë suppurée, Lyon méd. **155**:761 (June 23) 1935.

76. Sargnon: Nez et oeil. Etude clinique et thérapeutique, Ann. d'oto-laryng., April 1935, p. 428.

diseases. Some of his observations may be summarized as follows: 1. Diseases of the orbit have little influence on the nose except in cases of new growths or descending infection via the lacrimal apparatus. 2. Diseases of the nose, on the other hand, play a large part in the development of pathologic processes in the eye and orbit. Trauma to the nose may lead to secondary infection in the orbit. New growths, especially of the middle meatus and the ethmoid and the maxillary sinuses, frequently invade the orbit. Nervous disease of the nose may cause definite ocular symptoms. A knowledge of the nose-eye reflexes is of great value not only in a physiologic sense but from the point of view of pathology as well. Intranasal surgical measures, especially removal of the posterior and of the middle turbinate bone, which the author considers a direct trauma to the sympathetic nervous system, may lead to lasting reduction of the circulation in the retina. Diseases of the inner portion of the eye (the uveal tract, the iris, the choroid and the retina) may be the result of disease of the posterior sinuses, whether manifest or latent. In cases of papillitis and retrobulbar neuritis the results obtained by operations on the posterior sinuses, even when a pathologic process is not disclosed, are due to reduction of arterial blood pressure in the retina.

Headache and asthenopia, according to Smith,[77] are frequently caused by sinus disease. He has seen numerous cases in which refraction failed to relieve the symptoms but in which they yielded subsequently to treatment of the sinuses.

Chambers [78] claims that many ocular conditions are due to sinus infection even though the symptoms of the latter are slight and the roentgenograms unreliable. Watson-Williams, in the discussion of this article, states that he too found roentgenograms unsatisfactory and advises irrigation of the suspected sinuses, with microscopic and bacteriologic examination of the secretions.

Vecino, Alberto and Pietra [79] distinguish 2 groups of cases of sinus disease with orbital complications: serous sinusitis and suppurative sinusitis. They present cases of the former in which removal of the middle turbinate resulted in cure. For the suppurative or phlegmonous type they advise external incision plus intranasal removal of the middle turbinate. At times the Caldwell-Luc or the Seiffert frontal operation may be indicated.

77. Smith, J. A.: The Eyes as Related to Sinusitis, J. M. A. Georgia **24**:219 (June) 1935.

78. Chambers, E. R.: The Sinuses in Relation to Eye Diseases, Proc. Roy. Soc. Med. **28**:1582 (Oct.) 1935.

79. Vecino, S.; Alberto and Pietra, R.: Zur Behandlung der Orbitalkomplikationen der Nebenhöhlenerkrankungen, Rev. argent. de otol. **4**:213, 1935.

Iwaszkiewicz [80] analyzes 732 cases of sinus disease, in 22 (3 per cent) of which the condition was associated with ocular complications. These originated from the ethmoid sinus in 12, the frontal sinus in 6, the antrum in 2 and the sphenoid sinus in 1. There were only 2 cases of retrobulbar neuritis, in both of which improvement followed an operation on the sinus.

In a study of 120 patients with chronic posterior uveitis, Gill [81] found sinus infections in 48 per cent, the majority of which were of the ethmoid sinus. The duration of the antecedent sinusitis averaged slightly over two years. He claims that low grade infection affects the vascular tunic of the eye, especially the choroid vessels. There is a liberation of enzymes through disintegration of choroid cells. These act on the uveal pigment, converting it into a substance which is subsequently absorbed and acts as an allergen. Such patients when tested with uveal pigment nearly all gave heightened reactions. It is often difficult to eradicate the pathologic process in the sinus on account of a low grade osteitis with tendency to recurrences. Patients with such a condition require careful postoperative treatment.

Haas [82] states that many cases in which the condition is termed osteoperiostitis orbitalis are in reality instances of sinusitis exterioris. Frequently the clinical symptoms of sinusitis may be absent or minimal, but the direction in which the bulb is displaced constitutes an unfailing indication of the sinus at fault. He cites a case of a woman aged 72 who had edema of the lids with displacement of the bulb laterally but no symptoms of sinusitis. The diagnosis was made by roentgen examination. The author made two incisions, one through the brow and the other as for a dacryocystotomy, and through these incisions he was able to exenterate the frontal and ethmoid sinuses. The advantage of the dual incision was minimal scarring.

In a case of Layton's [83] no pus was found. In 2 of the other cases simple incision sufficed. In the fourth case the abscess recurred, and a second operation was required, with removal of the frontal floor and the introduction of a rubber tube. Howarth in the discussion expresses

80. Iwaszkiewicz, J.: Von der Nase ausgehende Komplikationen an den Augen und Augenhöhlen nach den Zahlen und Beobachtungen der Oto-Laryng. Klinik der Universität Posen, Polski przegl. otol. **11**:94, 1935; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **26**:26, 1936.

81. Gill, W. D.: The Clinical Relationship of Infections in the Upper Respiratory Tract to Certain Types of Chronic Uveitis: A Preliminary Report, Ann. Otol., Rhin. & Laryng. **44**:486 (June) 1935.

82. Haas, E.: Sinusite fronto-ethmoïdale extériorisée, Bull. Soc. d'opht. de Paris, February 1935, p. 107.

83. Layton, T. B.: Four Cases of Orbital Cellulitis Secondary to Nasal Disease Treated by Simple Incision, J. Laryng. & Otol. **50**:915 (Dec.) 1935.

a wholesome fear of possible osteomyelitis from external operations. He points out that many children with this condition may escape operation if treated by frequent shrinkage and intranasal applications. David and O'Malley also favor persistent adequate intranasal drainage and resort to external incision only if pus is definitely present.

In a summary of a paper read before the Scottish Otologic and Laryngologic Society on Nov. 17, 1934, Hall [84] reports 23 cases of orbital infection with 4 deaths. The cases are divided into two groups: those in which the condition was an external infection, such as a boil, erysipelas or trauma, and those in which it was due to sinus infections. In the former group it is the more dangerous (all of the fatalities were from this group) and requires radical treatment. The cases in which the infection is of intranasal origin may be dealt with more conservatively.

Møller [85] reports 6 cases of orbital abscess due to sinus infection occurring in persons between the ages of 11 and 24. There were 3 fatalities from endocranial complications. Infection in the orbit may assume three forms: (1) periostitis, (2) subperiosteal abscess and (3) orbital phlegmon. Roentgenograms are important in diagnosis but require an expert roentgenologist for a satisfactory opinion. One must bear in mind that the presence of old infections may obscure the picture. All orbital phlegmons do not require immediate operation. Many persons recover under conservative treatment.

Pera [86] describes a case of acute suppurative otitis media with threatening mastoiditis, high fever, swelling of the lids, impairment of ocular mobility, proptosis and impairment of vision. The patient complained of severe pains in the distribution of the first division of the fifth nerve, and a diagnosis of probable thrombosis of the cavernous sinus secondary to the infection of the ear was made. Examination of the fundi disclosed no alteration in the disks, and aspiration of the orbits gave negative results. Nasal examination revealed a swollen middle turbinate but no evidence of pus. Roentgenograms demonstrated definite cloudiness of the ethmoid sinuses and absence of the frontal sinus. The otorrhea subsided, but pain and tenderness of the mastoid extending to the zygoma appeared along with paresis of the facial nerve. The author was about to open the mastoid and explore the ethmoid sinus via the orbit when the symptoms began to abate and subsided so rapidly

84. Hall, J. S.: Orbital Infections, J. Laryng. & Otol. **50**:690 (Sept.) 1935.

85. Møller, J.: Ueber orbital Phlegmone, in Kubo, Ino: Festschrift zu seinem 60. Geburtstag, Tokyo, The Herald Press, Ltd., 1934, p. 85; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:458, 1935.

86. Pera, G.: Considerazioni su di un caso di etmoidite con complicazione orbitaria in ammalato di otite media purulenta-acuta con paresi del faciale, Ann. di med. nav. e colon. **41**:74 (Jan.-Feb.) 1935.

that resolution took place spontaneously within a week. The author contends that the orbital symptoms were due to stasis from blockage of the ethmoid labyrinth by a swollen turbinate and that this condition was independent of the otitis media and the sudden acute paresis of the facial nerve, all of which subsided spontaneously. Influenza was the cause of both conditions.

In Dintenfass' [87] case of sinusitis which developed after a cold the patient had pains in the eye, blurred vision, edematous lids and edema of the retina in the macular region. The symptoms were relieved after puncture and lavage of the antrum. The author believes that the infection of the eye was due to contiguity rather than to a purely toxic factor.

Iikura [88] performed a radical operation on the antrum of a patient, aged 17, in whom diplopia developed which lasted three weeks and disappeared gradually. The author attributes the symptoms to a dehiscence in the orbital floor which was noted at operation and is of the opinion that the bulb was temporarily displaced by edema.

Yuzefova's [89] case was unusually interesting. A man of 20 suffered periodic pains in the nose and eye, photophobia, lacrimation and loss of visual acuity. In addition, there appeared edema of the lids, increased secretion of the meibomian glands, conjunctivitis, diffuse haziness of the cornea, a cloudy anterior chamber, a fixed pupil and lessened corneal sensitivity. The usual local and general therapy were of no avail. At times the patient suffered from acute pains at the internal angle of the eye and tenderness along the side of the nose. Roentgen examination revealed a cloudy antrum. After opening and drainage of the sinus the symptoms began to ameliorate, and within a month the eye was restored to normal.

Dusseldorf [90] operated intranasally on both frontal sinuses in a man of 48. At the conclusion of the operation he instilled a 5 per cent solution of zinc chloride into one of the sinuses. This was immediately followed by severe intra-orbital pain and edema of the lids, with eventual necrosis of the upper lid. The bulb was fixed and there were exophthalmos and anesthesia of the cornea, with subsequent ulceration and perforation. After twenty days the necrotic upper lid sloughed off. Finally the bulb, tear sac, tarsal tissues and a portion of the lower lid were removed. In the author's second case a man of 20 who had

87. Dintenfass, H.: Edema of the Retina Due to Maxillary Sinusitis, Laryngoscope **45**:138 (Feb.) 1935.

88. Iikura, T.: Vorübergehendes Doppelsehen nach der Radicaloperation des Kieferhöhlenempyems, Otologia (Fukuoka) **8**:246, 1935.

89. Yuzefova, F.: Case of Nasociliary Nerve Syndrome Caused by Infection of the Antrum, Sovet. vestnik oftal. **6**:417, 1935.

90. Dusseldorf, M.: Zwei Fälle von zufälligem Eindringen endonasal eingeführter Flüssigkeiten in die Orbita, Arch. de oftal. de Buenos Aires **10**:74, 1935.

been operated on for chronic infection of the ethmoid sinus had severe pain for several months. For this reason alcohol was injected into the region of the resected middle turbinate. This was followed immediately by pain in the eye, diplopia, paresis of the internal rectus muscle and slight exophthalmos. After several weeks the patient had fully developed paralysis of the internal rectus muscle, which lasted for five months. In the discussion Sena cited a case of a 16 year old girl whose antrum was irrigated with a dilute solution of sodium hypochlorite, with resulting edema of the lids and three days later an orbital phlegmon with thrombosis of the central artery. Incision yielded pus, but the eye remained blind.

Wood [91] has had good results from operation on the sinus in cases of lesions of the optic nerve and disturbances of function of the ocular muscles supplied by nerves coming through the sphenoid fissure. However, his results with nasal treatment of scleritis, choroiditis, opacities of the vitreous, intra-ocular hemorrhages and iritis have been less definite. He advises against radical operation until all other causes of the condition have been ruled out.

Ferraris [92] cites a case of neuritis optica in which the sphenoid sinus was operated on on the forty-third day after the blindness, and cure resulted. He discusses the literature on the subject and concludes that neuritis is rarely due to sinusitis. He claims that the results of those who do not operate are as good as those who do. There is a natural tendency toward spontaneous recovery in cases of neuritis optica, which statistics fail to demonstrate properly. The author is against opening the posterior sinuses unless there is definite evidence of disease.

Fisher [93] quotes from many sources to show that there is still a lack of agreement as to the rôle of sinusitis in cases of optic neuritis. He finds that ophthalmologists are rather less inclined to credit the sinuses with the etiologic significance that is ascribed to them by rhinologists. The authors quoted vary in opinion from those who believe that cures following operation are spontaneous cures to those who report enthusiastically their results from operation. The author is still unconvinced, but he feels that in doubtful cases operation should be performed even though in a certain percentage it may prove to have been unnecessary. Yet, the risk of operation being slight, it is worth taking when other

91. Wood, V. V.: The Connection Between the Nasal Sinuses and Certain Eye Lesions, J. Oklahoma M. A. **28**:55 (Feb.) 1935.

92. Ferraris, G.: Neurite ottica da sinusite sfenoidale operata e guarita. Considerazioni critiche, Arch. ital. di otol. **47**:557 (Aug.) 1935; abstr., Zentralbl. f. Hals-, Nasen- u. Ohrenh. **25**:678, 1936.

93. Fisher, J. A.: The Present Status of Sinus Infection as an Etiologic Factor in Retrobulbar Neuritis, Tr. Am. Laryng., Rhin. & Otol. Soc. **41**:297, 1935; Ann. Otol., Rhin. & Laryng. **44**:274 (March) 1935.

measures have failed to halt the process in the optic nerve and symptoms point to the sinus.

Ramadier, Guillon and Morance [94] are also of the opinion that operation should be performed in cases in which the diagnosis is doubtful. They report 3 similar cases; operation was performed in 2 with practically negative findings but excellent results, whereas in the third case the patient refused to have an operation and became blind. The authors claim that the operation is especially justified in those cases in which optic neuritis is accompanied by pains in or about the eye, forehead or root of the nose.

Dunnington,[95] on the other hand, advises conservatism and claims that optic neuritis is characterized by a tendency to spontaneous cure. He feels that before operation on the sinus is undertaken in these cases, one must rule out intracranial lesions and multiple sclerosis.

Bécuwe [96] discusses acute suppuration (orbital abscess), osteomyelitis phlegmon of the lid, nonsuppurative cellutitis, phlebitis, infections of the lacrimal sac and retrobulbar neuritis. He is in favor of early intervention in cases of progressive optic neuritis when general and constitutional diseases have been excluded. He claims that the results justify the method. Some of the good results obtained after removal of the middle turbinate bone are due to the effect on the sympathetic nervous system, many of the fibers of which coming from the sphenopalatine ganglion pass over the middle turbinate.

Caliceti [97] records his observations in a case of purulent dacryocystitis with epiphora and blepharoconjunctivitis caused by hyperplastic ethmoiditis. He points out the great importance in diagnosis which attaches to some minor objective nasal signs and the correct interpretation of the roentgenograms. He presents some excellent results obtained with a large opening into the anterior ethmoid cells by a technic similar to Halle's except that the mucosal flap is triangular instead of quadrilateral. The author believes that all patients with an ocular lesion of obscure origin should be subjected to a rigid nasal examination, including roentgenographic study for possible evidence of a focus of infection.

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94. Ramadier, J.; Guillon, H., and Morance: Blindness (with Papilledema and Central Scotoma) and Intranasal Operation: Two New Cases, Rev. d'oto-neuro-opht. **13**:256 (April) 1935.

95. Dunnington, J. H.: Etiology of Retrobulbar Neuritis, Laryngoscope **45**: 685 (Sept.) 1935.

96. Bécuwe, A.: Affections nasales et complications oculaires, Echo méd. du Nord **3**:995 (June) 1935.

97. Caliceti, P.: Le peri-dacrio-etmoiditi, Oto-rino-laring. ital. **5**:225 (May) 1935.

INTRACRANIAL COMPLICATIONS

Chatellier [98] devotes an entire number to the subject of abscess of the brain in relation to the ear, the sinuses and the nasal cavity, the article being too long to abstract. He presents numerous anatomic drawings showing how infections may reach the cranial structures from the sinuses. There is nothing new in the article, yet it is an excellent presentation of an important topic.

In a symposium on the same subject by Coates,[99] Yaskin [100] and Grant,[101] several interesting facts are brought out. Coates points out the practical unanimity of opinion among surgeons that one must respect preformed meningeal adhesions when treating abscess of the brain. Despite differences of opinion as to methods of approach and drainage, he feels that the type of operation should depend on the type of condition. He advises minimum manipulation and minimum trauma and has had good results from the use of packing of iodoform gauze for drainage. Reviewing the neurologic aspects of intracranial complications, Yaskin summarizes the salient features in diagnosis and emphasizes the need of cooperation between the various specialists who are usually called in. Grant favors ventriculography for localization. He also feels that the abscess should not be opened until it is encapsulated, which takes in at least from three to four weeks. Various methods of opening an abscess are described, but the author likes to use the exploring cannula, leaving a silver tube in place through which a rubber tube is inserted for permanent drainage. It is sewed in place and cut off flush with the skin. After remaining in from a week to ten days, it is gradually shortened until it is entirely extruded.

Vail [102] and Carter [103] also discuss this topic thoroughly. The latter repeats what has long been an accepted dictum, namely, that it is best to wait for encapsulation of the abscess as indicated by a fall in temperature and a decrease in the number of white cells and in the headache. He favors simple aspiration through a trephine opening. The

98. Chatellier, H. P.: Notions anatomiques nécessaires a l'étude des abcès encéphaliques d'origine naso-sinusale, Oto-rhino-laryng. internat. **23**:386 (June) 1935.

99. Coates, G. M.: Intracranial Complication of Rhinogenic Origin, M. Times & Long Island M. J. **63**:302 (Oct.) 1935.

100. Yaskin, J. C.: Neurological Aspects of Intracranial Complications of the Ear and Accessory Sinuses of the Nose, M. Times & Long Island M. J. **63**:305 (Oct.) 1935.

101. Grant, F. C.: Neurosurgical Aspect of Meningitis and Brain Abscess, M. Times & Long Island M. J. **63**:307 (Oct.) 1935.

102. Vail, H. V.: Rhinogenous Abscess of the Brain, J. Med. **16**:255 (July) 1935.

103. Carter, N.: The Treatment of Brain Abscess, J. Med. **16**:257 (July) 1935.

dura is opened by electrocoagulation to seal off the meninges, the abscess is punctured and a small rubber tube is inserted for drainage.

Flothow [104] also uses the cautery knife to open the dura and continues with it into the cortex until the abscess cavity is penetrated. When the abscess is opened, it is inspected through a long speculum carrying a light; it is packed with gauze, and two small rubber tubes are inserted. These drains are permitted to remain until extruded by the herniating brain. This insures evulsion of the capsule of the abscess. The process takes from ten days to three weeks. If the hernia does not take care of itself, it may be cut off with a ligature or cautery.

McIntyre [105] is impressed with the value of newer neurologic signs of involvement of the premotor area of the brain. These are Hoffmann's sign, reflex grasping and the contralateral flexion reflex. Hoffmann's sign is elicited by the observer's snapping the finger-nail of the patient's middle finger while the hand, fingers and arm are relaxed. A positive reaction is noted by sudden flexion of the patient's thumb and fingers. Reflex grasping, which is normally found in infants before the development of the pyramidal tracts, refers to involuntary grasping by the patient of any article drawn through his hand. Contralateral flexion is elicited when doing the Oppenheim test and consists of a flexion of the opposite thigh on the abdomen, of the leg on the thigh and extension of the great toe as in a positive Babinski sign.

Connor [106] presents a thorough and complete analysis of the neurologic aspect of abscess of the frontal lobe with a discussion of the general picture as well as of the various focal symptoms which may appear. Although he can find no pathognomonic neurologic picture of this condition, he nevertheless presents sufficient evidence of the frequency of localizing signs which are of great value not only in diagnosing the lesion but in localizing it.

A case of abscess of the frontal lobes is described by Piquet and Decoulx [107] in which there were no symptoms to indicate the presence of the second abscess. They believe that such a condition is due to abnormal development of one sinus extending beyond the midline or to bilateral sinusitis or osteomyelitis. In the authors' case the main abscess crossed the midline by way of the corpus callosum, which they consider a rare occurrence. There was also a smaller abscess behind

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104. Flothow, P. G.: Treatment of Brain Abscess, Laryngoscope **45**:596 (Aug.) 1935.

105. McIntyre, H. D.: Diagnosis of Brain Abscess in General; Rhinogenic Abscess in Particular, J. Med. **16**:182 (June) 1935.

106. Connor, C. E.: Neurological Aspects of Frontal Lobe Abscess, Tr. Am. Laryng., Rhin. & Otol. Soc. **41**:188, 1935.

107. Piquet, J., and Decoulx: Abcès du lobe frontal consécutif à une sinusite frontale, Echo méd. du Nord **4**:48 (July) 1935.

the main cavity, which was apparently metastatic. Such an abscess could not be diagnosed by the usual clinical signs.

An extremely interesting case of abscess of the brain due to a penetrating foreign body is described by Ertl.[108] A 12 year old boy stumbled into a bush, and a dry twig was thrust into the nasal cavity, which he immediately removed. There was a severe hemorrhage followed by unconsciousness, and on the next day there were high fever, headache, restlessness and vomiting. These symptoms kept up for three weeks, when the patient was admitted to a hospital. A small piece of wood was found in the right nasal chamber. Mild symptoms of meningeal involvement were present. The reaction to the Pandy test was positive. There were 130 lymphocytes. Mydriasis was noted on the left. In the next few days there was a tendency to somnolence, and a left Babinski sign, a positive Oppenheim sign and paresis of the left facial nerve were observed. Eight days after the patient's admission the right frontal and ethmoid sinuses were opened, and a small amount of pus was discovered. The dura was exposed widely over the roof of the ethmoid sinus and behind the frontal sinus. Numerous punctures of the brain eventually disclosed an abscess of the left frontal lobe, which was drained through the falx into the right nasal chamber. The symptoms of meningitis increased, and death ensued. Autopsy demonstrated that the foreign body entering the right side of the nose had perforated the septum and then the left lamina cribrosa and the roof of the left ethmoid labyrinth. These openings were filled with connective tissue and were discovered only by following the direction taken by the penetrating piece of twig. The difficulty in diagnosis was due to the following reasons: The presence of a lesion on the right side was assumed because of the contralateral symptoms and seemed certain in view of the known portal of entry of the foreign body into the right nostril. Only the presence of mydriasis on the left side should have pointed to a lesion on that side, because it has been shown by von Bergman that such a symptom may be caused by a homolateral lesion with increased pressure.

Szende [109] tells of a case of agranulocytosis in a man of 59 in which an ulcer of the hard palate perforated the antrum and spread to the ethmoid sinuses and through the cribriform plate, causing an abscess of the frontal lobe and purulent meningitis, from which he died. The author believes with Schultz that the disease is "only a biological variant

108. Ertl, E.: Hirnabszess infolge von Pfälungsverletzung der Nase, Monatschr. f. Ohrenh. **69**:429, 1935.

109. Szende, G.: Case of Agranulocytosis with Sinus Inflammation and Brain Abscess, Acta oto-laryng. **22**:135, 1935.

of sepsis." He adds: "We have a right to ask whether agranulocytosis is not spirillosis partly because of the influence of arsenic and because of the resemblance of the clinical form of the ulcer to Lues."

Lischkoff [110] claims to have found reported in the literature only 5 cases of abscess of the brain secondary to sphenoiditis. His case is interesting because of the latency of the process. A period of two months elapsed from the time of operation for acute spheno-ethmoiditis until the sudden death of the patient, during which time there were no symptoms suggesting intracranial involvement. The results of a neurologic examination one day prior to the patient's death were negative. The initial infection was so stormy that the author removed the middle turbinate and opened the ethmoid and sphenoid sinuses, releasing much thick pus and gelatinous secretion under pressure. The symptoms were relieved, and the patient returned to work. Dull headaches and mental sluggishness persisted despite negative neurologic signs. Later the patient was in an accident which brought his cerebral symptoms to a climax, with vomiting, convulsions, etc. Autopsy revealed a large ruptured abscess on the inferior surface of the frontal lobe with a fistulous opening into the sphenoid sinus. The roof of the sinus was necrotic.

Sander [111] reviewed a number of recent reports on abscess of the brain and found that in only 8 per cent of the cases was the condition due to infection of the frontal sinus. In one of the author's cases the abscess developed with remarkable rapidity, the symptoms appearing within twenty-four hours after a radical operation for pansinusitis. There were attacks of epileptoid seizures, loss of consciousness, cyanosis and irregular nystagmoid movements which lasted fifteen minutes. Probing the brain was fruitless, until in desperation the author blindly made a vertical incision into the brain and evacuated a drachm of semiliquid caseous material and grumous pus. The patient recovered. In the author's second case the condition was a long-drawn-out affair resulting from an infection of the frontal sinus secondary to maxillary sinusitis. The patient was operated on eight or nine times in the course of four months and had multilocular abscesses in the frontal lobe. The interesting feature was the appearance of impairment of mobility on the left side, the abscess being on the same side. The abscess was uncovered on the left side because the local symptoms pointed to this location. Autopsy revealed no pathologic process in the right hemisphere.

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110. Lischkoff, M. A.: Latent Brain Abscess Secondary to Sphenoid Sinusitis with Case Report, South. M. J. **28**:700 (Aug.) 1935.

111. Sander, P.: Clinical Notes on Two Cases of Abscess in the Frontal Lobe, J. Laryng. & Otol. **50**:33 (Jan.) 1935.

Steurer [112] believes in the hematogenous transmission of infection from the sinus mucosa to the endocranium. He describes a case of extradural abscess in a boy of 11 which was uncovered at a point remote from the affected sinus and on the opposite side. The abscess was sought for and discovered only after several operations in the immediate vicinity of the sinus had failed to uncover an adjacent pathologic process. The boy recovered.

Eagleton [113] claims that the bone marrow of the sphenoid body retains its young red marrow, which possesses greater resistance to infection than yellow marrow. This explains the rarity of sequestrums in this bone. Frequently meningitis may ensue, and the symptoms of the initial sphenoiditis may be absent, especially if the infection is pneumococcic. The author claims to have cured meningitis due to Pneumococcus type II by simple drainage of the sphenoid sinus.

Feldstein [114] describes a form of aseptic meningitis of sudden and rapid onset with high fever, severe headache, neuralgic pains, ocular symptoms, a Kernig sign and a stiff neck. The spinal fluid is under high pressure, clear, free from bacteria and unchanged chemically and cytologically (*hydropsie meningée*), or it may show polynucleosis and albumin (*meningite aseptique*). It indicates a meningeal reaction to infection in the vicinity, and unless the focus is promptly drained it may lead to bacterial invasion. The prognosis is good if treatment is instituted early. The author cites Worms as having published reports of 5 such cases in which there was recovery. Frequently there is a history of a chronic or subacute sinusitis which for a time has been latent.

MacGregor and Smith [115] give a detailed description of a case of osteomyelitis of the parietal bone in a child of 8 years after an acute attack of pansinusitis. There were symptoms of abscess of the brain, probably of metastatic origin. Autopsy disclosed an abscess of the frontal lobe and a large subdural abscess covering the parietal lobe and extending forward to the frontal area and downward on the medial surface below the temporal and occipital lobes to the floor of the middle fossa. The superior sagittal sinus contained a septic clot through its

112. Steurer: Zur Frage der Entstehung von Extraduralabscessen bei Stirnhöhlenentzündungen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **38**:189, 1935.

113. Eagleton, W. P.: Meningitis: The Result of Disease of the Petrous Apex and Sphenoidal Basis, Surg., Gynec. & Obst. **60**:586 (Feb.) 1935.

114. Feldstein, E.: Les états méningés aseptiques d'origine sinusienne, Rev. gén. de clin. et de thérap. **49**:25 (Jan. 12) 1935.

115. MacGregor, A. R., and Smith, A. B.: A Case of Sagittal Sinus Thrombosis and Subdural Abscess Following Nasal Sinusitis, J. Laryng. & Otol. **50**:600 (Aug.) 1935.

entire length, which was partly liquefied into clear pus. The meningeal veins tributary to the area of the subdural abscess were also thrombosed.

In Pera's [86] case there were acute otitis media, acute mastoiditis with paralysis of the facial nerve and symptoms suggesting thrombosis of the cavernous sinus. Further examination revealed an acute suppuration of the ethmoid sinus with orbital complications associated with congenital absence of the frontal sinuses.

Goldman [116] reviews 12 cases of thrombosis of the cavernous sinus occurring during a period of twelve years at the Mount Sinai Hospital. In 4 cases the origin was traced to the sinuses: the ethmoid sinuses twice, the ethmoid and maxillary sinuses once and the ethmoid and sphenoid sinuses once. In the last-mentioned instance the condition was associated with osteomyelitis. Three of the patients were children. The author stresses the importance of conservatism in the treatment of acute sinusitis to avoid spread of infection. "A perforated infected sinus, an acute empyema of a sinus draining badly, a persistent bacteremia complicating acute sinusitis and signs of meningeal irritation are the conditions which require immediate surgical intervention."

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116. Goldman, J. L.: Cavernous Sinus Thrombosis Following Intranasal Infections, J. Mt. Sinai Hosp. **2**:121 (Sept.-Oct.) 1935.

(To be concluded)

Abstracts from Current Literature

Ear

Otogenous Abscess of the Parietal Lobe. Cyril B. Courville and J. M. Nielsen, Arch. Surg. **30**:930 (June) 1935.

The unusual occurrence of abscess of the parietal lobe secondary to otitis media merits the study of a series of six cases. These cases present nothing unusual from the anatomic or the clinical standpoint. The occurrence of abscess of the parietal lobe secondary to otogenic subdural abscess, to osteomyelitis of the parietal bone or to otitic abscess of the frontal or temporal lobes is believed to be rare. It is most probable that the infection is transmitted to the parietal lobe by way of the venous pathways, as suggested by the frequent association of thrombosis of the lateral sinus and that of the associated venous channels. This may occur with or without gross occlusion of the adjacent veins.

Sperling, Philadelphia. [Arch. Neurol. & Psychiat.]

Hearing Reclamation and Preservation in the Moderately Deafened Child. Edmund Prince Fowler, New York State J. Med. **35**:287 (April 1) 1935.

Many persons with from slight to moderate deafness do not realize the defect, especially if only one ear is subnormal. Hearing defects in school children are best detected by the 4-A audiometer. When deafness is detected careful functional tests and otologic examinations should be made. Fowler reports on a survey of 600,000 school children in New York City. The study was made possible by funds from the Department of Education and the Civil Works Administration. Two hundred and eighty teachers were given special instruction in lip-reading and in the use of audiometers. Cooperation was secured from medical societies, clinics of hospitals and otologists. The chart used for records is very complete. "The greatest difficulty is to obtain proper advice and treatment for the nonsurgical cases." Much of the treatment given to such patients as a routine may do more harm than good. Prevention should be stressed in every case. Lip-reading not only is an immediate aid but gives insurance if deafness increases. Deafened children should be given front seats in school, and teachers should be instructed in using their lips properly in articulation. Clear enunciation and a good view of the teacher's lips are always important. Moderately deafened children should continue their studies in regular classes. The greatest handicap of the deaf child is not being permitted to hear common words and the thoughts of others. Apparent stupidity may be due to this cause. Proper guidance will overcome this handicap, especially if individual hearing devices are provided. "A front seat and individual consideration appear to give greater satisfaction than a hearing aid alone." The children with greater loss of hearing require special attention and instruction. Special schools should be provided for the severely deafened. Recurrent infections of the upper respiratory tract should be prevented when and if possible. Conservative otolaryngologic treatment is stressed.

Aikman, Rochester, N. Y. [Am. J. Dis. Child.]

Discharging Ears Treated by the Iodine Powder Method. R. H. Bettington, M. J. Australia **1**:747 (June 15) 1935.

Bettington reports excellent results in the treatment of discharging ears with a powder which consists of iodine (0.75 per cent) and boric acid (99.25 per cent).

The ear is irrigated and then dried and the powder blown in. Both acutely and chronically discharging ears respond well to this method of treatment.

GONCE, Madison, Wis. [AM. J. DIS. CHILD.]

PSEUDOPNEUMATIZATION: AN EVALUATION OF ROENTGENOGRAMS OF THE MASTOID. H. E. ZANGEMEISTER, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:187, 1935.

Zangemeister directs attention to the discrepancy which sometimes exists between the roentgenologic determination of the pneumatization of the mastoid and the type of ear disease, that is, to contradictions of Wittmaack's theory of pneumatization. He cites the conditions observed in two patients, one of whom was operated on because of a suspicion of carious disintegration, and the other, because of signs of meningitis. In both the bone was found to be compact substantia spongiosa without signs of caries. There was a discrepancy between the roentgenologic and the surgical observations in that the roentgenogram had indicated a system of pneumatization which was not present. Zangemeister decided to examine series of mastoid sections for histologic aspects that might throw some light on this problem. In a considerable number of mastoids he found a bone structure similar to that existing in parvicellular pneumatization in which there existed in place of the aerated spaces a cellular filling of fat marrow. These pseudocells were not lined with mucous membrane; only in a few places appeared a filling that resembled the subepithelial mucous membrane, without there being mucous membrane epithelium. It may be expected that such mastoids will produce roentgenograms like that which is found when there is an irregular pneumatization with medium-sized cells and with a somewhat veiled appearance as observed in cases of acute otitis with inflammatory involvement and a transudate filling the formerly aerated cells. Zangemeister thinks that such pseudopneumatization existed also in another patient who had bilateral acute otitis media, in the treatment of which surgery was dispensed with. The roentgenograms of both ears presented similar aspects.

EDITOR'S ABSTRACT.

NEURINOMA OF THE PERIPHERAL PART OF THE FACIAL NERVE. F. ALTMANN, Monatschr. f. Ohrenh. **69**:1032, 1935.

Altmann presents the symptomatology of a disorder which is caused by tumors of the type designated as neurinoma and which, in view of the localization of the growth in the region of the middle ear or in that of the external auditory meatus and in view of the clinical symptoms, seems to originate in the facial nerve. He reviews some earlier reported cases and gives the histories of several others. His summarizing comment is based on six cases. With the exception of one case, all occurred in rather young persons (aged between 16 and 26). The first symptom of the disorder is always paralysis of the facial nerve, which usually persists during the entire course of the disorder. This paralysis is often for a long time the only clinical symptom of the disease. If the ear is examined, the auditory meatus is usually found partly or completely filled by a polypous tumor, which seems to originate on the posterior wall of the external auditory meatus. The tympanic membrane, as far as it can be seen, is usually intact and remains so for a comparatively long time. The hearing is likewise normal in the beginning but later becomes impaired, either because the growing tumor obstructs the external auditory meatus or because the tumor involves the middle ear. When the latter involvement is present the tympanic membrane may be destroyed and suppuration of the middle ear may develop. A correct diagnosis can be based only on an exploratory excision. If the findings are negative, the incision should be repeated, particularly if a secondary chronic suppuration with granulation tissue has developed. The growth of the tumor is usually rather slow and may even cease for several years. The growth is dangerous on account of its position near the middle ear or near the labyrinth, for these locations involve the danger of complications in the middle ear, the labyrinth or even the brain. On the basis of his therapeutic observations Altmann advises that ray therapy should be dis-

pensed with, but that surgical treatment is advisable, particularly during the early stages, when there is still hope of counteracting or improving the facial paralysis. Regarding the prognosis, he says that it is favorable as far as the life expectancy of the patient is concerned, provided, of course, severe complications are prevented, but that it is unfavorable as far as local restitution is concerned.

EDITOR'S ABSTRACT.

CLINICAL ASPECTS OF MESENCEPHALIC DEAFNESS. H. BRUNNER, Monatschr. f. Ohrenh. **69**:1049, 1935.

Brunner shows that mesencephalic deafness is the result of an interruption in the auditory conduction between the inferior colliculus and the medial geniculate body (isthmus acusticus). Particularly the peduncles of the quadrigeminal bodies and the medial geniculate bodies respond to a destructive process with an auditory disturbance, whereas lesions of the inferior colliculus itself and of the lateral lemnisci are not so often accompanied by an auditory disturbance. An interruption of the conduction of the auditory tract at the site designated is frequently followed by a descending degeneration in the cochlear system, which can be traced into the spiral nerves of the cochlea. The secondary atrophy of the cochlea may be unilateral or bilateral, depending probably on the position of the tumor. The atrophy may involve the greater part of the cochlea or may be limited to the vestibular and basal coils. It may be assumed that the secondary cochlear atrophy plays the same part in mesencephalic deafness as it does in deafness caused by a tumor of the acoustic nerve. If the interruption of the conduction involves the auditory tracts of both sides the auditory disorder is bilateral; if the interruption of the conduction is unilateral a contralateral auditory disturbance is the result. Mesencephalic deafness develops especially in the following conditions: (1) a tumor of the tegmentum of the mesencephalon that develops caudally from the red nucleus, (2) a thalamomesencephalic tumor, (3) a pineal tumor and (4) a suprasellar tumor. A tumor of the tegmentum of the corpora quadrigemina as a rule produces no auditory disturbances; nevertheless Brunner thinks that under certain conditions it may. A pinealoma that penetrates into the third ventricle impairs the auditory conduction sooner than a tumor of the lamina quadrigemina that penetrates into the pulvinar. Mesencephalic deafness is usually a late symptom (even of pinealoma), and for this reason it has an unfavorable prognosis; it usually progresses rather rapidly, and it is usually accompanied by a hyperirritability of the labyrinth.

EDITOR'S ABSTRACT.

HEREDITARY ATROPHY OF THE ACOUSTIC NERVE. N. A. POPOV, Ztschr. f. Hals-, Nasen- u. Ohrenh. **37**:407, 1935.

Popov points out that the disorder under consideration is not so well known under the term applied to it here but rather under such terms as "congenital deafness" or "congenital deafmutism," "heredodegenerative deafness or baryecoia," "labyrinthine baryecoia of young persons" and "progressive labyrinthine deafness or baryecoia," all of which have been combined under the general term "heredopathia acustica." He reports observations on two members of a family with hereditary deafness. He gives a diagram of the genealogical tree of this family and then discusses the anatomic aspects of congenital deafness. After citing the opinions of other investigators regarding the mode of hereditary transmission, he says that on the basis of the present knowledge it may be said that the hereditary transmission of congenital deafness may be according to the recessive as well as to the dominant type. His own observations seem to indicate this. Moreover, in the family studied by him alcoholism may be regarded as a hereditary narcomania. It is possible that the concurrence of the two disorders is not entirely accidental; the chronic alcoholic intoxication of the ancestors of this family might have caused the hereditary disease of the auditory nerve, particularly since it is known that alcoholism may be related to various neuropathies and psychopathies.

EDITOR'S ABSTRACT.

AN UNUSUAL VESTIBULAR SYMPTOM PRODUCED BY CALORIC STIMULATION IN PATIENTS WITH PONTILE TUMORS. S. KREPUSKA, Ztschr. f. Hals-, Nasen- u. Ohrenh. **37**:414, 1935.

After stressing the importance of otologic methods of examination in the diagnosis of cerebral disorders, Krepuska describes a reaction to caloric stimulation that he observed in three patients with cerebral tumors. Stimulation of the vestibular apparatus with water of a temperature of 68 F. according to the Kobrak-Veits method did not elicit the usual reaction (nystagmus lasting one hundred and twenty seconds) but rather a visual paralysis or an ocular spasm. In this cramped condition the patient was able to turn the eyeballs in the direction of the calorization but not in the opposite direction, for the bulbi remained fixed in the median position. There was no nystagmus. The reaction lasted from three to five minutes, after which the movements of the eyeballs became free again. In one of the patients a solitary tuberculoma was found on the pons varolii; serial sections of the pons were made and were histologically examined according to Weigert's method. These studies gave information not only about the clinical symptoms but also about the mechanism and the pathogenesis of the so-called visual paralysis. It was detected that this condition was caused not only by an impairment of the abducens (sixth cranial) nerve but also by a common lesion of the abducens and oculomotor nuclei, and that, moreover, paralysis of the posterior longitudinal fasciculus likewise played an important part. Krepuska concludes that a vestibular caloric reaction of this type is helpful in demonstrating latent visual paralysis and thus is a valuable aid in the early diagnosis of a pontile tumor.

EDITOR'S ABSTRACT.

Pharynx

THE PEDIATRICIAN LOOKS AT THE TONSIL. R. M. POLLITZER, J. South Carolina M. A. **31**:146 (Aug.) 1935.

First, the anatomic situation of the three groups of lymphatic tissues are described. Then the indications for removing the tonsils are briefly summarized—"repeated attacks of tonsillitis, increasing in severity, with or without systemic disturbance." The enlargement of the anterior cervical glands accompanying or following these attacks is emphasized. The experience of Kaiser of Rochester, N. Y., is cited. This author concluded that infection of the tonsils is a factor in causing rheumatic fever, scarlet fever and chronic heart disease but that tonsillectomy influences unfavorably the incidence of bronchitis, pneumonia and sinusitis.

When it has been decided that the tonsils should be removed, thorough physical examination, a complete blood count, determination of the coagulation and the bleeding time and urinalysis should be carried out.

This paper provoked much discussion, particularly from otolaryngologists.

WESTON JR., Columbia, S. C. [AM. J. DIS. CHILD.]

THE TONSILS AND THEIR RÔLE IN FOCAL INFECTIONS. ABRAHAM H. PERSKY, M. Rec. **141**:432 (May 11) 1935.

Two types of tonsils cause disturbance: 1. Large tonsils that produce obstructive symptoms. The effects of this type are always local. 2. Tonsils that are not enlarged but that produce toxic or focal symptoms. This type is the real source of danger to the patient. Persky discusses the focal manifestations, first considering certain symptoms of associated diseases and placing them in groups, such as (1) the rheumatic group, (2) the cardiovascular group, (3) the genito-urinary group and (4) other groups. In conclusion, he states that the tonsils play an extremely important rôle in focal infections; if they are the only focus, cure can be brought about by their removal if surgical removal is attempted early before permanent changes have occurred in the tissues. He condemns the use of electrocoagulation.

WILLIAMSON, New Orleans. [AM. J. DIS. CHILD.]

ACUTE TONSILLITIS: AN ACCOUNT OF SOME RECENT STREPTOCOCCAL INFECTIONS. F. E. CAMPS, Brit. M. J. **1**:1061 (May 25) 1935.

In a definite geographic area, more or less circumscribed, an epidemic of tonsillitis occurred which was more severe than usual. Investigation showed that the main etiologic factor was the beta hemolytic streptococcus—Streptococcus pyogenes. Other types also occurred. A general description of the outbreak and the predominant symptoms in several cases follows.

The appearance of the throat is described carefully, and an outline of special complications is given; these include acute mastoiditis, cellulitis of the neck, acute nephritis, arthritis, fibrositis and headache. The treatment, both general and specific, is outlined. In a certain number of cases, especially in those in which there was associated nephritis, arthritis or cellulitis, serum was used. Camps thinks that the results justified the use of the serum.

The differential diagnosis is then discussed. The summary is as follows:

"Although cases of scarlet fever have occurred locally during the last year, there has also occurred an epidemic, which has been more severe, of streptococcal tonsillitis, due to one or more types of haemolytic streptococci.

"The majority of the cases showing complications have improved with treatment with polyvalent antistreptococcal serum and the other measures described.

"Before concluding, one question appears extremely relevant: Are we any longer entitled to regard scarlet fever as a separate disease to be accepted by the public health authorities as a ground for notification and isolation?"

ROYSTER, University, Va. [AM. J. DIS. CHILD.]

THE VEGETATIVE NERVOUS SYSTEM OF CHILDREN WITH ADENOIDS. RINA SIMONETTI CUIZZA, Riv. di clin. pediat. **33**:641 (June) 1935.

The method of di Jeva (Il sistema neuro-vegetativo nel bambino, *Riv. di clin. pediat.* **28**:203 [March] 1930; abstr., *Am. J. Dis. Child.* **40**:655 [Sept.] 1930) was used to evaluate the preponderance of parasympathicotonic (vagotonic) or of sympathicotonic reactions in patients. The effects following injections of epinephrine, atropine and pilocarpine on the pulse rate, the respiratory rate, the blood pressure, the skin and the eyes were observed in each child. Of twenty-four children with adenoids, aged from 3 to 11 years, ten showed definite vagotonia; five, sympathicotonia, and the remaining nine, dystonia (i. e., neither vagotonia nor sympathicotonia). The author concludes that children with adenoids should be considered as having dystonia, with a tendency to vagotonia.

HIGGINS, Boston. [AM. J. DIS. CHILD.]

ROENTGENOTHERAPY OF OROPHARYNGOLARYNGEAL CARCINOMAS. J. BORAK, Monatschr. f. Ohrenh. **69**:1108, 1936.

Borak employs a modification of the Coutard method of protracted fractional roentgen irradiation. Whereas Coutard permits a minute flow of only 4 roentgens, Borak permits minute flows of from 15 to 20 roentgens. He differentiates three kinds of doses: the anepitheliolytic, the subepitheliolytic and the epitheliolytic. As anepitheliolytic he designates those doses which produce in the surroundings of the tumor either no changes or at the most slight hyperemia. The subepitheliolytic doses are those which produce in the surroundings of the tumor mild hyperemia and eventually slight edema. The epitheliolytic doses are those which produce in the surroundings of the tumor considerable hyperemia and subsequent edema. He says that the anepitheliolytic doses are almost entirely ineffective. To be sure, reversions of various degrees were effected with these doses but never complete disappearance of an epithelioma of the mucous membrane. The subepitheliolytic doses effected a primary disappearance of a carcinoma of the mucous membrane in six of twelve cases. The epitheliolytic doses produced the best results. This was indicated not only in that a primary disappearance of the tumor was effected

in 89 per cent of the cases but also in the more favorable late results. Concerning the bearing of the localization of the tumor Borak says that when the tumor was in the tonsils or in the larynx, the results were relatively favorable, but when it was at other sites in the oral cavity or in the pharynx the results were unfavorable. In the last part of his paper he discusses the latest modifications of Coutard's method, especially the so-called Coutard-Baclesse method.

EDITOR'S ABSTRACT.

STERILE ANIMAL PLASMA AS A HEMOSTATIC AGENT AFTER TONSILLECTOMY. A. TOBECK, Ztschr. f. Hals-, Nasen- u. Ohrenh. **37**:463, 1935.

Tobeck resorted to the use of a sterile coagulable animal plasma in twelve cases of hemorrhage after tonsillectomy. He injected the preparation into the peritonsillar tissue near the site of bleeding. The hemorrhage was promptly controlled in all but one of the cases. The one failure was ascribable less to the preparation than to the faulty technic of injection. For the control of the less severe hemorrhages 1 ampule of the animal plasma was usually adequate, but when the hemorrhages were severe 2 ampules were administered. The chief advantages of the use of the animal plasma are: 1. The technic of administration is simple. 2. The administration is practically painless and thus does not tax the weakened patient. 3. The action of the plasma is quick and reliable. 4. The plasma is harmless.

EDITOR'S ABSTRACT.

Nose

THE RÔLE OF DISEASES OF THE NASAL ACCESSORY SINUSES IN HEADACHE. JAMES W. BABCOCK, Bull. New York Acad. Med. **11**:481 (Aug.) 1935.

This paper is part of a symposium on headache given before the New York Academy of Medicine. Headache due to disease of the sinuses is usually worse in the middle of the day, becoming less severe in the late afternoon or evening. This is due to spontaneous drainage following the erect position for from eight to ten hours. In cases of severe acute sinusitis this headache may persist (absence of drainage). The pain in the head is independent of the degree of inflammation.

The location of the pain varies with the involvement of the different sinuses. However, Babcock cautions that not all headache is due to sinusitis and that only on diagnosis of sinus disease by accepted methods is one justified in attributing the pain in the head to involvement of the accessory sinuses.

JAHR, Omaha. [AM. J. DIS. CHILD.]

THE PROBLEM OF COLDS IN CHILDREN. JOSEPH S. STOVIN, M. Rec. **142**:505 (Dec. 4) 1935.

In Stovin's experience the most effective method for treating colds and acute sinusitis in children is the instillation of mild vasoconstrictors, followed by gentle suction. Strong vasoconstrictors and germicidal agents are to be avoided. The use of tampons is contraindicated. To prevent colds, proper air conditioning of homes is important. Rooms are generally overheated, and there is usually too little humidity. Ultraviolet irradiation has been recommended. A change of climate is of benefit; the southern parts of Florida and California are particularly recommended. The common cold is just as prevalent in children who have had their tonsils and adenoids removed as in other children.

Vaccine therapy is still far from satisfactory. The author feels that no sure method for the prevention of colds has been evolved.

WILLIAMSON, New Orleans. [AM. J. DIS. CHILD.]

CHRONIC ETHMOIDITIS IN CHILDREN. LOUIS LEROUX, J. de méd. de Paris **55**:503 (June 6) 1935.

Leroux points out that the ethmoid cells develop much earlier than the sphenoid cells, the antrum or the frontal bone. Five cases of chronic ethmoiditis in infants and children are reported. The condition is said to be more frequent than is generally recognized and has not as yet been sufficiently studied. Clinically, it occurs most frequently in children who have had their adenoids removed and who have repeated colds and "stopping-up" of the nose. Rhinoscopy shows degenerative changes of the middle turbinate bone. The condition may be associated with infection of the other sinuses. No adequate method of treating this condition in children has yet been found. LESLIE, Evanston, Ill. [AM. J. DIS. CHILD.]

PERFORATION OF BONY WALLS AS A COMPLICATION OF SINUSITIS. J. OHRINGER, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:72, 1935.

After pointing out that perforations of the frontal sinus occur most frequently on the orbital wall and least often on the cerebral wall, Ohringer suggests that this is probably owing to the fact that the orbital wall is usually the thinnest and has the most preformed apertures. The site of predilection for a perforation is not, as has been suggested by some, the frontolacrimal suture but rather the sites of exit of two venules, one in the upper internal orbital angle and one behind the incisura supra-orbitalis. Perforations of the bony walls may develop in acute as well as in chronic suppuration. If the orbital wall is perforated an orbital abscess develops; if the posterior wall is perforated cerebral complications may develop. The perforation is usually small. The thickness of the bone or of the periosteum is of no importance. There are various possibilities for the development of the perforation: 1. The inflammatory process may be transmitted through the apparently intact bone in that a granulating inflammation causes the development of microfistulas along the vessels. 2. If these fistulas become larger there is the transmission by macroscopic fistulas. Both these types of transmission are the result of rarefying osteitis. 3. Thrombosis of a vein that passes through the bone and transmission of the infectious material to the other side of the bone may produce perforation. 4. The inflammatory process may be transmitted by dehiscences of the bony wall. The conditions mentioned under points 1 to 3 occasionally occur in the same case. In the medullary spaces the same processes of fusion take place as in the vascular canals. Thus perforation develops by way of rarefying osteitis and osteomyelitis with or without thrombosis and with or without the formation of a macroscopic fistula. After reviewing reports by other investigators, Ohringer describes a case of acute suppuration of the frontal sinus that led to an orbital phlegmon. Observations on this case indicate that in the perforations of a frontal sinusitis the granulating resorption processes along the vessels of the bone play the most important part. A vascular thrombosis is not necessary. EDITOR'S ABSTRACT.

THE STRUCTURE AND DEVELOPMENT OF THE FRONTAL SINUSES. A. E. SITSEN, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:79, 1936.

In investigating the literature on the structure and development of the frontal sinuses Sitsen found many problems that were not yet clear, and he also detected contradictory opinions. Accordingly he decided to investigate this matter anew. He describes studies on the frontal sinuses of children and adults of various age groups. Before he evaluates his observations he defines as a frontal sinus every hollow space within the frontal bone which is lined with mucous membrane and is connected with the nasal cavity. In summarizing his studies regarding the origination and growth of the frontal sinuses he says that they can be traced to a decomposition of parts of the frontal bone, particularly of the substantia spongiosa, whereas the compact bone gives greater resistance. Wherever the sinus borders on the diploe bone is formed on the medullary side of the intervening trabeculae. This densification of the substantia spongiosa forms a bony wall separating the

sinus from the diploe. At the sites where there is no substantia spongiosa the compact portions of the frontal bone form the wall of the sinus. In addition to the decomposition there is also a building of bone tissue, in that parts of the surfaces showing decomposition become covered with a layer of lamellar bone. In the early stages of the development of the sinus the decomposition is especially noticeable on the top; later this process is less active and ceases at times. The building on of bone tissue is already observable in young sinuses, but later it becomes more pronounced and it continues into the advanced ages. However, the covering bone layer always remains rather thin, rarely exceeding a thickness of 200 microns. In some parts, the newly formed layer of bone becomes decomposed again. Sitsen was unable to find any indication that the mucous membrane plays a part in pneumatization. However, he thinks that pressure from the cavity plays a part and thinks of increased air pressures in the sinus. He believes that the great variability of the frontal sinuses can be explained on the one hand by the action of the air pressure and on the other by the differences in the structure of the frontal bone. He gained the impression that slight development and even complete absence of the frontal sinuses may be regarded as not necessarily due to an inhibition of development but as still within the limits of normality. EDITOR'S ABSTRACT.

Miscellaneous

CLINICAL SPECTROSCOPY IN ARGYROSIS. L. E. GAUL and A. H. STAUD, J. A. M. A. **104**:1387 (May 20) 1935.

Gaul and Staud warn of the danger of argyria from the indiscriminate use of colloidal silver preparations and report seventy cases. Within the past year they observed fifteen cases in children under 10 years of age. In these the condition developed following intranasal application of argyrol and neosilvol. As there is no treatment for argyria at present, these children will be discolored for life. The degree of discoloration depends on the duration and intensity of solar or artificial radiation. Argyria becomes clinically apparent when an amount of silver the equivalent of that in 0.8 Gm. of silver arsphenamine is retained. Analysis by biospectrometric methods affords a new test for the identification of argyria.

BONAR, Salt Lake City. [AM. J. DIS. CHILD.]

THE COMMON COLD: A SURVEY OF RECENT WORK. C. H. BROWNING, Glasgow M. J. **123**:329 (June) 1935.

Colds are the greatest single cause of illness. The duration is from three days to three weeks. Coryza is present in 90 per cent of the cases but occurs alone in only 18 per cent; cough and sore throat are present in the rest. Sixty per cent of persons have from two to three colds per year; 17 per cent have one or less, and 23 per cent have four or more.

The following theories have been suggested in regard to the causation: (*a*) The cold is due to some agent not harbored by those attacked, e. g., the Eskimos. (*b*) The agent is probably a filter-passing virus; it can be produced in chimpanzees and cultured in vitro. (*c*) Ordinary organisms found in the nose and throat may play a part in colds; they certainly do in the complications. (*d*) The incidence of colds is independent of climate but has a relation to sudden changes in the weather. (*e*) The incidence of colds has no relation to individual living habits.

In regard to prophylaxis, nasal douches and mouth washes have no effect. Vaccines are apparently of no value. There is no evidence that dietetic factors except gross lack play any part. Tonsillectomy and nasal operations have no effect.

In therapeutic experiments a group of university students was divided into two parts, and one group was given codeine and papaverine. Seventy-five per cent of the treated group reported improvement in one day. Thirty-five per cent of the controls, all of whom thought that they were receiving the same drugs, also reported improvement. Acetylsalicylic acid and sodium bicarbonate seemed to have no effect. SNELLING, Toronto, Canada. [AM. J. DIS. CHILD.]

MUCOCUTANEOUS ULCERATIVE TUBERCULOSIS OF THE NOSE, PHARYNX AND EYES. M. GRENET, P. ISAAC-GEORGES and L. LANGLOIS, Bull. Soc. de pédiat. de Paris **32**:96 (Feb.) 1934.

A girl 3 years old had an ulcerative lesion on the lower outer margin of the right side of the nose at the age of 1 year. This was accompanied by coryza, which persisted for many months. The eyes became involved with phlyctenular keratoconjunctivitis, and indolent ulcerative lesions appeared on the soft palate and pharynx. The child looked scrofulous. The tuberculin reaction was strongly positive, and a roentgenogram of the chest showed evidence of tuberculous infection. The Wassermann reaction of the blood was negative. Although tuberculous infection of the scrofulous type has been described as developing on a syphilitic background, one should bear in mind that it may exist in the absence of syphilis.

BENJAMIN, Montreal, Canada. [AM. J. DIS. CHILD.]

INFLUENCE OF THE SPLEEN ON ALLERGIC CONDITIONS. C. R. GRIEBEL, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:101, 1935.

Griebel reviews the literature on the functions of the spleen and describes his studies of its influence on allergic conditions. He made sugar tolerance tests on rabbits, some of which had first been sensitized by repeated subcutaneous injections of small amounts of an allergen. The allergic animals showed considerable eosinophilia. In tolerance tests it was proved that the metabolism of sugar is disturbed in these animals in that the blood sugar reaches an unusually high level and remains at this high level for much longer periods than it does in animals that have not been made allergic. However, when the allergic animals were given an injection of an extract of spleen (free from protein, sugar and lipoid) previous to the sugar tolerance test the reaction was considerably reduced toward the normal. In other experiments the reticulo-endothelial system of the animals was blocked. Griebel concludes that clinical observations as well as experiments on animals indicate that the spleen exerts a considerable influence on the eosinophilic blood picture. It was found that the administration of an extract of spleen in allergic disturbances (bronchial asthma, vasomotor rhinitis and hay fever) produces the best results in vasomotor rhinitis; in hay fever the effects are less favorable, and in bronchial asthma they are least favorable. To be sure, the eosinophilia was reduced in all of these conditions, but only in vasomotor rhinitis was this reduction accompanied by a cure. Griebel considers spleen therapy promising in the treatment of allergic disorders.

EDITOR'S ABSTRACT.

TRACHEAL SARCOMA IN A CHILD. L. ABBATE, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **140**:179, 1935.

Abbate reports the clinical history of a girl aged 10 who suffered from increasing dyspnea. Tracheoscopy revealed a spherical tumor above the bifurcation. After the proper tracheal tubes had been constructed, tracheotomy was done. After it had been determined that the tumor was 8.5 cm. below the lower rim of the tracheotomy wound, the tumor was removed piece by piece by means of curets, while the patient was in Trendelenburg's position. The histologic examination of the removed tissues revealed a sarcoma. It was decided to resort to after-treatment by means of radium. A special container was constructed which permitted free passage of air around the capsule containing the radium. The radium was introduced for from forty-five to sixty minutes at a time. Twelve treatments were given. After six treatments the rather bumpy surface from which the tumor had been removed could no longer be differentiated from the surrounding swollen and reddish tissue. Nine months later the examination revealed a circular zone of shiny brownish-red tissue which appeared atrophic; that is, it resembled the mucous membrane in pharyngitis sicca. Tracheoscopy from time to time disclosed no recurrences.

EDITOR'S ABSTRACT.

Society Transactions

AMERICAN LARYNGOLOGICAL ASSOCIATION

Fifty-Eighth Annual Congress, Detroit, May 25, 26 and 27, 1936

BURT R. SHURLY, M.D., *President*

CHARLES J. IMPERATORI, M.D., *Editor of Abstracts*

ADDRESS BY THE PRESIDENT OF THE AMERICAN LARYNGOLOGICAL ASSOCIATION, DR. B. R. SHURLY, DETROIT

The honor of presiding is sincerely appreciated by me as the crowning event of forty years in the practice of medicine and laryngology in an attempt to follow in the footsteps of my illustrious uncle, Dr. E. L. Shurly, president of this association fifty-one years ago. The way has been difficult; the standards of efficiency, loyalty, intelligence and love for fellow man as exemplified by such pioneers set a pace that required superhuman efforts in medical scholarship, to be approached with fear and trembling.

The great era of specialism was on the horizon in those days, and the younger generation endeavored to carry on over the trails blazed. Our literature is a story of progress, invention and accomplishment in the science and art of laryngology, and what Dr. E. L. Shurly said fifty-one years ago still holds: "We can point with pride to the fact that, as one of the stars in the galaxy of the science of medicine, laryngology has not been wanting in lustre." The basic ideals laid down by the forefathers have been exemplified by research and postgraduate training.

I believe the standard of the organization cannot be too high or the selection of members too carefully made, for it matters not if there are but twenty-five or thirty workers in the hive if these are men of ability, industry and observation, bent on bringing out all the facts connected with the subjects comprised in this department of science. This society has led the way in teaching and in the publication of textbooks and special literature.

As a member of a committee that established specialists in the army and navy in the World War and as a member of the American Board of Otolaryngology for the past ten years, it became a question with me to determine "who is a qualified otolaryngologist." This has been a great and difficult problem, but it is being solved by the board with increasing success.

The Advisory Board of the Special Examining Boards, the idea of which originated with the members of the American Board of Otolaryngology, includes many other branches of medicine in its scope, and the demand of this board to raise the requirements is being favorably received by all.

Postgraduate medical education has been greatly stimulated and improved within the past few years, and slowly but surely the old world is giving way to the new.

The term "a safe man" has permeated all discussions and all objectives for the past ten years, and yet no definition of a safe man has been given a stable concensus. According to my idea, there is no safe man in otolaryngology who does not understand the essentials of internal medicine and the responsibility of guarding the life of the patient.

And how about the laity? Are they not in need of constant and concentrated education? Why should the modern days require an intelligent woman to enter my

office with a list of seventeen different specialists, including chiropractors, osteopaths and physical therapists, to treat a cold? The remedy is better and broader educated specialists. This organization must stand collectively and individually against socialization of medicine and the various plans of social insurance that would ultimately wreck the profession.

While otolaryngologists have these epoch-making problems as controversial subjects before them, this association cannot consider them, as they belong to the county society and the halls of the House of Delegates of the American Medical Association.

As individuals, however, the members can throw great influence to a dignified solution of these important problems that will again restore in the American public veneration, respect and pride in the marvelous achievements of medical research and practice.

Thanking you for the greatest honor that can come to a worker in laryngology, I declare the Fifty-Eighth Congress of the American Laryngological Association in session.

SEPTIC AND ASEPTIC TYPES OF THROMBOSIS OF THE CAVERNOUS SINUS: REPORT OF CASES. DR. W. E. GROVE, Milwaukee.

This paper concerns itself with (1) a review of the available literature, (2) the anatomy of the cavernous sinuses and of their afferent and efferent venous connections, (3) the etiology, symptomatology, prognosis and treatment of thrombosis of the cavernous sinus and (4) the history of the surgical treatment of thrombosis of the cavernous sinus and its results. The paper closes with four case records. Three of the cases exemplify thrombosis of the cavernous sinus, and the fourth is introduced to illustrate the difficulties of differential diagnosis.

DISCUSSION

DR. H. P. MOSHER, Boston: I agree with the reader that there probably are many cases of aseptic thrombosis of the cavernous sinus which go unrecognized. To recognize them, however, requires very great diagnostic skill and very great good luck.

There are cases on record in which operation resulted in success. The procedure that I refer to was either straight removal or evisceration of the contents of the orbit or this plus tying of the common carotid artery.

I should like to make this suggestion: In a case (the process has to be in a fairly early stage, of course) in which only one eye is involved or in which the second eye is only slightly involved, do a radical exenteration of the ethmoid. In some of the cases, as in the last one reported by the reader, the lesion is nothing but an orbital abscess giving signs of thrombosis of the cavernous sinus; the patient will get well. Operate on the ethmoid sinus and then wait a few days. If progress is not favorable, open the sinus after the fashion of Lynch and make an entrance into the orbit posteriorly. There, I think, will be found, in many of the cases, a collection of pus which comes from the sinus, draining anteriorly. I surmise that in some of these cases one will get favorable results.

DR. M. C. MYERSON, New York: I feel it incumbent on me to answer Dr. Grove's statement about his impression of the operation which Broder and I advocate for the short circuiting or prevention of infection of the cavernous sinus when infection is advancing toward it.

Members who are conversant with the paper by Broder and myself will recall that we had a patient whose trouble started with a carbuncle of the nose. He had proptosis and chemosis of the conjunctiva; he had a chill and a rise in temperature; he had Staphylococcus aureus in his blood, and the same organism was isolated on culture from the carbuncle. Therefore, we felt that we had a patient whose condition was progressing toward thrombophlebitis of the cavernous sinus. In other words, there was every reason to feel that this patient would have the other eye involved by progression of the disease across the straight and circular sinuses.

Therefore, I feel that the statement is not right that the operation which we advocate might be used in cases of orbital cellulitis.

The operation advocated is that of coagulation of the cavernous sinus before the infection reaches it in cases, usually of carbuncle of the nose, in which an infection has involved the ophthalmic vein.

Dr. Mosher's suggestion is good. My colleagues and I feel the same way, that immediately after coagulating the cavernous sinus we should eviscerate the orbital contents.

I should like to call Dr. Grove's attention to the fact that in the presence of thrombosis of the lateral sinus with thrombophlebitis or with the thrombus extending backward we do not hesitate to cross the circular sinus or to expose the superior longitudinal sinus until we get bleeding from the opposite side or above; so we always get bleeding from that side.

It is our impression that although Staphylococcus aureus is always present in the acute fulminating infection Streptococcus is also present. The reason the literature does not state that Streptococcus haemolyticus is present is because Staphylococcus aureus overgrows it in the culture. Therefore, cultures should be made for the hemolyzing organism, and the bacteriologist should be instructed to look for it. It is the presence of this streptococcus that gives the fulminating, early fatal involvement.

DR. G. F. HARKNESS, Davenport, Ia.: Since the essayist saw fit to include the arteriovenous aneurysm I should like to call attention to a simple procedure. Six or seven years ago I encountered a traumatic case in which there was a bruit that could be heard 8, 9 or 10 inches (20, 23 or 25 cm.) away from the patient's head, one in which compression stopped the bruit, but in which the patient was not able to stand the compression for any length of time.

On the suggestion of the patient a very simple procedure was carried out. The compression apparatus that had been devised were rather complicated. We obtained a couple of old-fashioned bicycle pants' guards, padded one end and fitted the guard to this man's neck. I showed him how to put it on the carotid artery. He would put that on and wear it as long as he could and then take it off. He did this for from six months to a year. That was six or seven years ago. There is now no bruit. Little exophthalmos remains, and his vision is good.

DR. W. E. GROVE, Milwaukee: Dr. Mosher mentioned an orbit studded with small abscesses. That is a condition which can be confounded with orbital abscess. I do not like to sacrifice an eye unless the infection of the cavernous sinus is absolutely definite. The vision in some eyes with orbital abscess when the sinus is not involved will return to normal, as in case 4, which I reported.

Dr. Mosher spoke of tapping an abscess of the cavernous sinus by the operation which he so brilliantly worked out and described. If the cavernous sinus is frankly purulent I cannot see how merely tapping the abscess will effect a cure.

As I stated in my paper, the structure of the cavernous sinus is different from that of the lateral sinus. It is made up of not one single chamber but of from one to fourteen separate chambers. It is impossible to tap all and get permanent drainage. Furthermore, when there is frankly purulent infection in this sinus the meninges very rapidly become involved.

I apologize to Dr. Myerson for neglecting to state that there was bacteremia in his patient. All of the signs except bacteremia may be present, of course, with orbital abscess.

With regard to the remarks on bleeding from the torcular region, I have for many years not endeavored to get free bleeding from this region because I firmly believe that the clot or thrombus in that part of the sinus is a protective mechanism to shut off the infection. When that clot is taken away to get free bleeding nature simply puts another clot there.

Dr. Harkness spoke of the external clamp over the artery. That has been tried on my patient, but the external clamp used shuts off the circulation almost completely so that the woman cannot stand it for any length of time. I think it will probably be better to put a gradually tightening clamp on the carotid artery.

SURGICAL REMOVAL OF THE SPHENOPALATINE GANGLION: AN ORIGINAL TECHNIC TO EXPOSE THE PTERYGOPALATINE FOSSA, COMMAND THE INTERNAL MAXILLARY ARTERY AND ITS TERMINALS AND THE INFRA-ORBITAL NERVE AND ITS BRANCHES. REPORT OF THREE OPERATIONS. DR. E. C. SEWALL, San Francisco.

In 1928 an original method of entering the pterygopalatine fossa for the operative management of the sphenopalatine ganglion and neighboring structures was published. Since then the approach has been utilized abroad a number of times. My paper deals with the anatomy, physiology and pathology of abscess of the infratemporal fossa, of neuritides involving the sphenopalatine ganglion and with the significance of the sphenopalatine ganglion for atrophic rhinitis. The treatment described is surgical, consisting in the following procedures: incision over the canine fossa under the lip; entrance of the antrum; removal of the posterior wall of the antrum; opening of the periosteum; exposure of the internal maxillary artery; ligation of the internal maxillary artery or any of its branches in the infratemporal or pterygopalatine fossa; exposure and removal of the sphenopalatine ganglion or severance of any of its branches; exposure of the infra-orbital nerve at the round window, and its severance.

I report three instances in which the sphenopalatine ganglion was removed, the internal maxillary artery tied and the infra-orbital nerve severed at the foramen rotundum.

DISCUSSION

DR. J. C. BECK, Chicago: I should say that this is along the line of "much ado about nothing" if the recent work of Higby is correct indicating that the sphenopalatine ganglion has nothing to do with pain.

I go back in mind to the enthusiasm that marked the work of the late Sluder and the many who followed him in trying to establish a rationale for treatment of the sphenopalatine ganglion and the many pains and symptoms that it was supposed to produce and to the suffering that the patients underwent in order to get relief by injections and operative procedures.

To me these patients as I have watched them in company with very excellent neuropsychiatrists were neuropsychiatric. If the brilliant result in case 1 is to be taken seriously, to me it is just exactly what would be expected of a drug addict who has been influenced and even tells the story about his not taking drugs. Drug addicts are as a rule liars, so if I were Dr. Sewall I should not take that correspondence too seriously. The patient tells a very nice story; I have been misled by just such fabrications. A great deal of credit is to be given to Dr. Sewall for what he has done.

I should like to ask a question about the first operation done by one of his good assistants, the operation which Dr. Sewall did over again. Did he find that the ganglion had been missed or that it had returned or something of that kind?

DR. H. L. SWAIN, New Haven, Conn.: Fortunately, one does not have many patients of this type, and one regrets the experience each time that one does. I had a most interesting experience that revealed two things which I wish to call to the attention of the members and see if others have had the same experience. Sluder had seen my patient and believed that she had a "sphenopalatine ganglion complex." She had been operated on so many times and had had so much of the bone removed that each time I see that nose I have to reorient myself.

She will go two years without symptoms. (If anything I had done had resulted in an improvement that lasted over two years I thought I had done something remarkable.) Then, out of a clear sky, she has a beginning of pain. With the beginning of pain a red spot forms on the conjunctiva and another red spot on the cheek. During the entire time she has pain, weeks or months, these spots come and go. One can hardly do anything inside the nose unless one cocainizes it first, because the tissue which overlies the sphenopalatine ganglion has been reduced to such thinness that the slightest touch on it produces pain.

She has had all sorts of operations, both antrums opened, middle turbinates removed. She has had injections of alcohol up the sphenopalatine canal. Each and all of these have at one time or another relieved pain.

Dr. E. C. Sewall, San Francisco: So far as the removal of the ganglion in the first instance is concerned I could not say, because what I found was largely a mass of scar tissue without histologic evidence of a sphenopalatine ganglion in it.

The important matter is that an approach has been described which may be useful for other purposes than consideration of the sphenopalatine ganglion.

Further Observations on the Use of Specific Immune Serums in the Treatment of Streptococcic Infections. Dr. H. L. Baum, Denver.

This is a further report on the results obtained in the treatment of certain streptococcic infections by means of serums derived from persons recently recovered from streptococcic infections, chiefly scarlet fever. The results tend to show that such serums act specifically against streptococcic infections of varying location and severity and characterized in many instances by clinical manifestations essentially different from those from which the donors suffered. A method of selecting serums according to specificity against a particular invading organism is described, the theory on which this work is based is discussed, and the results of treatment are given. The limitations of the method so far as known are defined.

A Presentation of Patients, Instruments and Reports: A Case of Laryngoptosis. Dr. Gabriel Tucker, Philadelphia.

I present the history of a case of laryngoptosis due to shortening of the left sternohyoid muscle. Resection of a fibrous band that replaced the sternohyoid muscle gave a very satisfactory result. A speech defect was improved, and closure of the jaw could be accomplished when the head was in the normal erect position.

Fibrosis of a Lymph Node Involving the Recurrent Laryngeal Nerve. Dr. C. J. Imperatori, New York.

I present a specimen of the larynx and adjacent tissue showing fibrosis of a lymph node which involved also the vagus nerve, just above the aorta. The symptoms were those of recurrent paralysis of the left vocal cord.

Excision of the Epiglottis. Dr. M. C. Myerson, New York.

This specimen of the larynx shows an excised epiglottis. The excision was done to remove a cancerous growth. Following misplacement of a nasal feeding tube, the patient died. Attention is directed to the proper placement of the tube by auscultation and fluoroscopy.

Demonstration of Speech Defects in Children in the Public Schools of Detroit. Miss Clara B. Stoddard and Miss Mildred Gross, Detroit.

The patients presented demonstrate infantile speech, delayed speech, oral inactivity, congenital hyperthyroidism, pituitary dysfunction, secondary thyroid deficiency, lisping, lateral lisping, foreign accent, cleft palate, inarticulate speech, stammering, spastic conditions, spastic stammering plus very poor hearing, nutritional stammering and vocal disorders.

A pupil demonstrated the Fisher nasal emission indicator which shows by the flickering of a flame when air is coming through the nose.

A Routine Technic for Emergency Tracheotomy. Dr. W. B. Chamberlin, Cleveland.

Tracheotomy is performed (1) as a preliminary to various operations on the larynx and (2) as a method of relieving acute or chronic laryngeal obstruction. In an infant or a small child with a short fat neck the operation may be attended with considerable difficulty even in normal circumstances. If the patient is suffering from severe laryngeal obstruction the difficulty is much increased. Intubation

or bronchoscopy, even in the hands of the most experienced person, is difficult and time-consuming. The Mosher indirect "Life Saver" tube can be introduced more quickly than either the ordinary intubation tube or the bronchoscope. It is easily available since it can be carried in one's handbag. In the home, ward or operating room, after it is introduced it is held in position by an assistant or nurse, and with the operative area under local anesthesia the trachea is opened without undue haste or anxiety. After the introduction of the tracheotomy tube the Mosher tube is withdrawn. Illustrative cases are cited.

DISCUSSION

DR. M. C. MYERSON, New York: Emergency tracheotomy in the presence of severely urgent laryngeal dyspnea is always serious, and the method by which one shall manage best a given case depends on one's experience and previous training. There are several methods: If the operator is expert in bronchoscopy he can pass a bronchoscope very rapidly, but he should never pass it except when the patient is in the upright position or as nearly in the upright position as possible. Then there is the method of indirect intubation. If one is not experienced with intubation tubes or with the bronchoscope one would rapidly perform tracheotomy through the cricothyroid membrane to give his patient airway and then do tracheotomy below.

Incidentally, the Mosher indirect intubation tube is of great value when the trachea has been opened and the operator does not have a dilator to help him insert the tracheotomy tube. He can pass the Mosher tube into the trachea through the tracheal opening and then easily introduce the tracheotomy tube.

DR. H. P. MOSHER, Boston: This tube has double parentage. The first tube was a straight one and was used with the adjustable speculum. It should be put on record that the tube as now used in emergency work in the operating rooms of the hospital with which I am associated and on operating tables in other parts of the country is not due to me but to one who worked with me, Dr. Fink, now dead. It is really a combined tube (Mosher and Fink).

I should like to speak about one other method of performing tracheotomy. It is not so much an emergency method as it is a method to be used in connection with extraction of foreign bodies, especially those in the lungs. This procedure I have called the punch tracheotomy. It consists in tracheotomy with use of the Fink-Mosher tube if the occasion calls for this. Instead of displacing the thyroid isthmus up or down, one cuts it, clamps it and sutures it in order to get a dry field. Then the usual incision is made in the trachea with a cross incision, and the lumen is punched out from the trachea.

If one has taken pains with the thyroid isthmus there is no bleeding and one needs no tube for the first week.

DR. B. R. SHURLY, Detroit: This subject is just as alive as it was about forty years ago, since one never knows when one is going to have to use emergency measures. One never knows what time of the night or day one may be called on to perform tracheotomy with scissors or a jack-knife and some hairpins to keep the trachea open. The ability to meet this emergency is a part of the equipment of the general practitioner as well as of the consulting specialist.

My early experience with over five hundred intubations in about two years in this town, riding around in a horse and buggy night and day, with the horse galloping along over mud roads in the Polish districts, with insanitary situations, diphtheria, melon seeds and peanuts and with no bronchoscope, no esophagoscope and no x-ray machine, was perhaps training in meeting emergencies. The emergency tracheotomy came into use very, very frequently. My preference in such emergencies is intubation, because one can do it so quickly. If later one needs to carry out tracheotomy secondarily one always has a chance of relief from the intubation; this is of value. It seems to me that intubation is passing out; the opportunities for doing it are growing less. Those opportunities are concentrated, as they should be, in hospitals for patients with contagious diseases, and few, very few experts in carrying out that operation are necessary now.

The inventive genius of Dr. Jackson and his great staff of wonderfully trained inventors has brought newer methods into use by which dyspnea and obstruction of the larynx are taken care of beautifully.

Then, again, one has antitoxin. In the older days when one did tracheotomy one had to put a hot flatiron in a pail of water to get a little alkaline steam for the child to breathe through the tracheotomy tube. One had to have sublimations of mild mercurous chloride on a hot shovel, and one had to have steam made with hot bricks or whatever one happened to have handy around the house. Those measures have passed out because one has hospitals where tracheotomy can be done very quickly.

There are in this society many of the pioneers who did these emergency tracheotomies time after time, night after night, and a marvelous experience and a superior line of literature have come along, but it deals always with just the same subject. I want to thank Dr. Chamberlin for discussing it, for the procedure is the emergency operation. When some one is choking one has to help him, and one can never change that, no matter how great may be one's scientific knowledge or how extraordinary may be one's instruments.

I well remember some of those emergency tracheotomies that my confrères and I did with scissors and a penknife for retained intubation tubes, which we used to have to deal with quite frequently. I remember a series of seventeen instances that I reported in this society or in the American Triological Society in which the tubes were coughed out, and they could not be got back in. It was sometimes necessary to do an emergency tracheotomy, and even after the child had stopped breathing there was still a chance to bring it back to life.

The enthusiasm I drew from my first encounter with patients of this type—three brothers! The one I operated on was brought into the ward for patients with contagious diseases at Harper Hospital. One of the children was dead from diphtheria in the parlor of the home, ready for burial. The second one died in the ambulance on the way to the building for patients with contagious diseases, and the third, the only child left, was a wonderful little 4 year old boy. I did the tracheotomy as they brought him in the door of the building, the first tracheotomy I ever did. That is the kind of enthusiasm and inspiration that the younger men must experience in emergency tracheotomies—a successful effort, a dramatic effort, really, an effort that saves a life. The child who had died was brought in, and I intubated more than one hundred times; I learned how. That was the way young men had to learn in those days. Those days have passed.

It seems to me that this society, in its fifty-seven years of tremendous experience, service and pioneering, can very well have this subject and many others revived from time to time. When the doctor has to do such a tracheotomy he has to do it with anything that he has handy but always he must do it in the grand enthusiastic scientific spirit that he is going to save the child's life if he possibly can.

Dr. W. B. Chamberlin, Cleveland: Dr. Myerson spoke of doing the bronchoscopy only when the patient is in the upright position. That had never occurred to me.

Dr. Mosher spoke of the punch tracheotomy. I think that oftentimes one has to resect a portion of the tracheal ring, because if one does not and the pressure on the tube is great the pressure is bound to cause decubitus with subsequent sloughing of the cartilage, which is delicate and hard to control.

I remember one child who had a foreign body—a penny or a nickel—in its esophagus. Every time I put the esophagoscope in, the child stopped breathing. Finally I put a bronchoscope into the larynx and went ahead with the esophagoscopy without difficulty. The pressure of the tube on the esophagus, against the posterior wall of the trachea, cut off the breathing. One could introduce this Mosher tube much more easily into the trachea and then proceed with the esophagoscopy.

The experience to which Dr. Shurly has so feelingly referred is one that many of the younger men miss. I find in training them that they are more and more

disinclined to undertake anything that partakes of physical hardship. One of my recent assistants spoke of his fear of scarlet fever and subsequently of his fear of tuberculosis, and I suggested that possibly it would have been better if he had entered the career of bank clerk.

The Mosher tube is very easily carried in one's bag. It may not have to be used very frequently, but it is certainly a friend in need.

DR. T. J. HARRIS, New York: If it would be in order, I want to follow what Dr. Shurly has described as a dramatic incident with another because of the great lesson it taught a large group of men: It happened at the Pittsburgh meeting of the American Triological Society in connection with one of the most honored and respected members, who was doing a tonsillectomy. The breathing suddenly stopped. One of the very distinguished members of this society, who is present this afternoon, had for years taught the importance of being ready in the emergency of which Dr. Shurly has been speaking. I should say it was the most dramatic incident at which I have ever been present—to see that larynx opened and the patient's life saved. It was a question of a second.

DR. B. R. SHURLY, Detroit: Was not that in the days when peroxide was used to clean out the tonsils after tonsillectomy?

DR. T. J. HARRIS, New York: Yes.

DR. B. R. SHURLY, Detroit: Dr. Jackson will remember that very well. It was in his amphitheater at Pittsburgh. He has done more emergency tracheotomies than any one, I believe.

DR. CHEVALIER JACKSON, Philadelphia: The accident was the running down of a peroxide clot into the larynx. The operator's technic after doing an adenoidectomy was to put a swab up into the nasopharynx to check the bleeding. The nurse was unfamiliar with his method of operating. He operated with the patient in the sitting position, as was customary in certain sections and perhaps still is. With his own trained nurse at home, just as soon as that swab was put in, the patient was always put down flat so that clots could not form in the larynx, but in this strange operating room the nurse did not know that. The child was kept erect, and the larynx was filled with a very firm clot of peroxide-coagulated blood. I was not in the operating room at that stage. I was outside. My late lamented friend, Sidney Yankauer, came out and said, "Jackson, you had better get in there." I got in. I saw the cardinal signs, the last indrawing of the air with sucking in of the guttural fossa, and I recognized laryngeal obstruction. I knew nothing of what had happened before; I heard that afterward. The child now is a young woman, married, and the mother of three children. She still has one tonsil.

MONILIASIS OF THE LARYNX. DR. L. H. CLERF and DR. C. J. BUCHER, Philadelphia.

In most instances yeastlike fungi, usually referred to as Monilia, appear to be saprophytes; occasionally they become parasites. When they do they produce a lesion resembling a granulomatous infection, difficult to eradicate. Monilial infections have been observed in the larynx. The lesions, while not characteristic, present certain features which distinguish them from most of the commonly observed laryngeal lesions. The characteristics of the organism, the appearances of the lesion and the problems in treatment are discussed.

DISCUSSION

DR. CHEVALIER JACKSON, Philadelphia: Dr. Clerf referred to a patient who had blastomycosis of the larynx with a lesion on the skin and a suspected but undemonstrated lesion in the lung. I had a follow-up report on this patient. It has been eight years since the diagnosis was made. He still wears his tracheotomy cannula and refuses to have anything done toward decannulation. He has no

demonstrable lesion in the larynx, on the skin or in the lungs. On his own initiative he still takes 20 grains (1.3 Gm.) of potassium iodide every day because he feels that it was this which cured him.

The patient had visited a number of clinics, where the true diagnosis was not made and could not be made. The diagnosis arrived at clinically was malignant disease of the larynx, but that was unconfirmed by biopsy. The correct diagnosis was made by Dr. B. C. Crowell, who is now director of the American College of Surgeons. He discovered the organism in the tissue because he asked for and examined an unstained specimen. In the stained specimen the blastomycetes could not be seen. There were no mycelial threads. I should like to ask Dr. Clerf to state in his closing discussion whether or not staining the tissue obscures the blastomycetes when mycelial threads are not present.

Another cultural feature was that plates were inoculated (I do not know what the medium was), and the laboratory workers waited so long for a growth that they gave up and put the plates underneath the laboratory benches to be cleaned off later. About a month and a half later, when they got them out to clean them, they found a beautiful growth, and it was a pure culture of Blastomyces.

Dr. L. H. Clerf, Philadelphia: I cannot answer Dr. Jackson; in the rabbit livers the mycelium and the ascospores were brought out by staining. I cannot say whether one can find them in the fresh state or not. The medium used was Sabouraud's agar. That is the standard medium.

The point Dr. Jackson made with regard to the time is absolutely true. Many of those cultures were ninety day cultures. It takes a long time to find out what the condition is, but that, of course, is a secondary consideration. The important thing is to answer the question: Is the condition due to a fungus? If one can pin it on no other etiologic factor, then I think one is safe in assuming that it is a fungus infection until proved otherwise, and there is only one plan of treatment to be employed. In the meantime the laboratory can try to identify the fungus, and it will take about ninety days.

Transillumination. Dr. Lyman Richards, Boston.

This paper gives consideration to the status of sinus transillumination, its merits and demerits. A description is given of a new method of transillumination by means of the photo-electric cell whereby standard graphic numerical records can be made for individual patients to some extent analogous to audiometric records of deafness. The clinical application of this method is discussed.

In addition an experimental study in which this method was used in measuring the relative translucency of typical antral fluids such as blood, pus, mucus and serum is reported. A study of the comparative ability of the eye to detect differences in the translucency of these fluids is supplemented by a study of the sensitivity of the x-ray film to radiation through certain of these fluids.

The whole study offers for consideration a possible advance in the future technic of transillumination.

DISCUSSION

Dr. H. H. Forbes, New York: I do not think Dr. Richards' contribution should go by without discussion. Every now and then I am rather proud to think that I was born down in New England, where Dr. Mosher, Dr. Richards and some of the other members of this society come from. Since leaving there at an early age I seem to have lost the happy faculty of going into detail, whereas Dr. Richards and some of the other gentlemen have kept it up. I congratulate him. Perhaps it is because he moved to Boston and is near Harvard. Anyway, I feel as to the practical part of transillumination that when it shows positive evidence of involvement of the antrum one has indications for going ahead, and if one is in favor of washing out an antrum one can do it through the newer method that employs the natural opening. When transillumination gives negative results one is still at a loss for any—I will not say any—but a very small value in the use of transillumination.

THE VALUE OF ROENTGENOGRAPHY OF THE NECK WITH SPECIAL REFERENCE TO ITS USE IN THE DIAGNOSIS AND TREATMENT OF LARYNGEAL AND TRACHEAL OBSTRUCTION. DR. CHEVALIER JACKSON, Philadelphia.

Roentgenologic study of the neck has come to be of great aid to the laryngologist because it affords a method of detecting in the early stages not only retropharyngeal abscess but many other lesions affecting the soft tissues of the hypopharynx, larynx, trachea or cervical esophagus. Not the least important of its uses is in accurate localization of opaque or semiopaque foreign bodies in these regions. In addition, it is the best method of determining the size, shape and position of laryngostomy apparatus, tracheotomy tubes and other devices to be used in the treatment of laryngeal and tracheal stenosis. These and other uses of the diagnostic roentgen rays, are described and evaluated, with the use of numerous lantern slides for illustration.

DISCUSSION

DR. F. M. LAW, New York: One point which possibly should be spoken about is the necessity for close cooperation in this particular type of work between the bronchoscopist and the roentgenologist. I feel that the bronchoscopist should be as thoroughly skilled in the interpretation of films of the cervical regions as the roentgenologist is supposed to be. The observer knows what the larynx looks like on examination, and by examining the film carefully he can correlate his mental picture with the registration in the film.

I have seen a great many films made in different parts of the country and am much surprised at the difference in quality compared with what I have seen today. These are especially fine films. They are made with the proper technic. The bronchoscopist should himself be familiar with the necessity for proper technic. Very few roentgenologists hold the patient's head stiff. These films were made in a very quick exposure, but I have seen them made so that at the time of the pressing of the switch the patient swallows or moves. That spoils the film.

At the Manhattan Eye, Ear and Throat Hospital a film which does not show perfect detail just as would be expected in a dental film is discarded. Sometimes it is necessary to place the film in contact with the neck. For this purpose a special gadget has been used and found very valuable because of the difference not only in the quality but also in the relative size of the reproduction.

The bronchoscopist should learn to go into the fluoroscopic room with his eyes properly adapted. This is important. He should learn the appearance of the larynx as projected on the screen and compare that with the appearance in the film, and he will get a great deal more valuable information, a matter which Dr. Jackson has spoken of.

DR. C. J. IMPERATORI, New York: I feel that roentgenography of the larynx is an important part of the armamentarium, and it is particularly important in dealing with the patient in whom it is necessary to keep a tracheotomy tube over a long period. At present my colleagues and I have all patients who are tracheotomized roentgenographed immediately afterward and at subsequent periods, maybe every two or three months. Some years ago I attended a child in whom a tracheotomy tube had been placed some eight months previously, a Jackson tube and to all intents a proper tube. Suddenly this child was seized with emphysema and died. I presented the specimen before the American Bronchoscopic Society some years ago. My colleagues and I were able to see that there was a definite erosion in the trachea that had been produced by the end of the tracheotomy tube. I had not seen the child for about a month previous to its death. This in itself made me feel that there should be some check-up on all the persons who are wearing tracheotomy tubes over a long period. A roentgenogram properly taken is a great source of information.

CANCER OF THE LARYNX AND ITS MANAGEMENT. DR. R. E. BUCKLEY, New York.

Early diagnosis plus surgical intervention still seems to offer by far the best hope in the treatment of cancer of the larynx. Considerable enthusiasm has been

aroused since the introduction of the Coutard method of high voltage roentgen irradiation of cancer. This method is too recent and some of the results too disastrous to warrant its replacing surgical operation at present. Except in patients with extremely early and fairly localized cancers, a laryngectomy rather than laryngofissure offers the safest chance of cure.

The midline incision without the T incision and with separate lateral drainage may shorten the period of convalescence. Removal of the hyoid bone, especially when the lesion is extensive, gives a much larger field to work in and a better view. Immediate tacking of the trachea to the skin at the time of the tracheal incision prevents leakage of blood into the chest and makes it possible to proceed without the formerly used rubber hose dam. In well selected patients surgical operation offers excellent results in carcinoma of the larynx.

DISCUSSION

Dr. H. B. Orton, Newark, N. J.: Intrinsic cancer, as Dr. Buckley has said, and as has been very beautifully proved by colleagues here, offers excellent results to surgical treatment. When one comes to the extrinsic type one's results, I think, in the vast majority of cases are better if surgical operation is combined with irradiation than if irradiation is used alone.

I have been particularly interested in the extrinsic type. It is true that grade 4 malignancy is not very promising, but one may have a patient whose cancer is of grade 3 or 4, with the growth around the upper part of the larynx, where surgical operation followed by applications of high voltage roentgen radiation will be of vast service.

In describing the postoperative care Dr. Buckley brought out the very important point of getting the patient out of bed as soon as possible. I believe he said to encourage the patient to get out as soon as possible. I order my patients out of bed for fifteen minutes on the day following operation; thereafter I increase the amount of time afternoon and evening, and by the end of the week they are spending most of their time out of bed.

Dr. J. C. Beck, Chicago: Intrinsic carcinomas of the squamous cell type are being enthusiastically treated by irradiation; there are marvelous reports on such treatment by radiologists. It so happens that I am connected with an institution, the Veterans Administration Facility at Hines, Ill., where a radiologist is associated with the tumor clinic. This clinic receives neoplasms from veterans over the greater part of the United States. Many of the malignant growths are picked up very early; they are not sent in there with that diagnosis. The carcinomas I mention, located on the anterior third of a vocal cord, with no fixation, are ideal for treatment by laryngofissure; yet those, in small numbers, he has permitted to be treated by radiation, distant radiation, from radium, that is, radium pack, with the Coutard method very definitely and carefully carried out, for, as the members know, Coutard stated that he was using roentgen rays to imitate radium, feeling that radiation of that type would afford a positive cure for squamous cell carcinoma. Coutard has shown in his statistics a wonderful number of cures. I have not the courage to allow a carcinoma such as that described to go without at least a laryngofissure and even a complete section, but one must consider the statement made by the roentgen ray and radium experts that they do not believe type 4 can be cured.

After all, gentlemen, with laryngectomy, no matter how carefully it is done or how large the number of the recoveries, one leaves the patient not altogether happy. He may have an artificial larynx; he may learn to speak with the esophageal voice; it is a handicap. One saves his life, but if one can do as well by irradiation one ought to take that into consideration.

Dr. H. M. Goodyear, Cincinnati: One of the things I wish to emphasize, because I have found it rather important in these cases, is the use of local anesthesia. I know that Dr. MacKenty was rather opposed to the use of local anesthesia, and all the laryngectomies done at that time were done under general anesthesia. Local

anesthesia works perfectly well. I use sodium amytal and morphine, and I have had no trouble. In the last ten or twelve years all the laryngectomies I have done have been done under local anesthesia.

In providing for drainage I use the T incision. I make the incisions out on the far side of the neck and close the midline incision. I also pack the rather vacant cavity which is left in the side of the neck after the larynx has been removed with iodoform gauze and bring this out in the side openings of the neck.

Following operation I have given almost as a routine 3 units of insulin once or twice a day. Insulin has great value and usefulness in treatment other than that for diabetes. Insulin certainly has a good effect in producing an increase of metabolism and rapidity of healing.

The first day an attempt is made to move the patients a little from side to side, giving them just as much movement as possible. Hiccup often occurs. One thing I have found that helps is $\frac{1}{30}$ grain (0.002 Gm.) of apomorphine hydrochloride.

Dr. W. B. Chamberlin, Cleveland: In regard to irradiation versus surgical operation, there is no question but that with anything new one is likely to be overenthusiastic. In my opinion, irradiation should be limited to those carcinomas which are so far advanced that surgical intervention offers no possibility of relief. In the type of case to which Dr. Beck referred, that of a small growth limited to the anterior third of a vocal cord, I can see no reason or rhyme for using the roentgen rays when the wonderful results from laryngofissure are so well known.

Just a word in regard to the choice of laryngofissure as against total extirpation: There has been a decided tendency on the part of some to insist on total extirpation of the larynx regardless, apparently, of the end-result with the patient. As Dr. Beck has said, the patient who has undergone laryngectomy is most unhappy in spite of the artificial larynx, whereas the well selected patient with a laryngofissure has a very useful voice.

In this connection I have made inquiry of a friend of mine, Dr. A. I. Ludlow, who is home on a year's leave of absence. He is the head of the American College of Surgeons in Korea and is professor of surgery there. With the permission of the society I am going to ask Dr. Ludlow to relate his experience with laryngofissure. This operation, by the way, was done on himself. The operation was performed by Dr. Tucker within the last year. Dr. Ludlow is here, and I shall be very glad to introduce him to the members of the association.

Dr. A. I. Ludlow, Seoul, Chosen: Mr. Chairman, I do not wish to speak on this operation—only to stand before you as one who had an early diagnosis of his condition and fine treatment. I have gained 15 pounds (6.8 Kg.) since the operation.

I wish to thank this group for the wonderful progress that has been made in this line of surgery, and I bring to you the greetings of medical men in Korea and express again my appreciation to those who helped me so much.

Dr. Gabriel Tucker, Philadelphia: I should like to have Dr. Ludlow tell the members his experience with the tracheotomy tube. A tracheotomy was done because at the time of the laryngofissure it was felt that there would be edema in his larynx. Ordinarily one does not perform tracheotomy after laryngofissure.

I put in the tracheotomy tube. The first night Dr. Ludlow insisted that he was choking to death, although the tracheotomy tube was in position. Then he fell in love with the tube, and I could not get it out of him. He would not let me take it. I should like to have him give his impression.

Dr. A. I. Ludlow, Seoul, Chosen: I had done so many tracheotomies that I dreaded having one done on me. When I was on the operating table I heard Dr. Tucker say, "Well, I think we will put a tube in," and I thought the end had come, but it was very agreeable, no trouble at all. When Dr. Tucker wanted to remove it I said, "Please leave it in another day."

Dr. W. B. Chamberlin, Cleveland: I should like to add a word before Dr. Tucker speaks about the appearance of the larynx. I have followed Dr. Ludlow ever since his return and have seen him at least once a week during that time.

I saw him the day before I came away. He has a new-formed cord, which moves perfectly freely, just as well as the normal cord. The only difference that one can notice is that the cord on the side of the removal is somewhat thicker and somewhat more red than the cord on the opposite side. His voice speaks for itself.

Dr. Gabriel Tucker, Philadelphia: In our experience at the University of Pennsylvania there have been 262 patients with cancer of the larynx; 131 were considered suitable for surgical treatment. (Dr. Buckley is very favorable to laryngectomy.) In this group thirty-eight had laryngectomy, sixteen partial laryngectomy and eighty-four laryngofissure. Two patients had laryngofissure twice; that is, each had a recurrence, and laryngofissure was done a second time, without further recurrence. Four patients had laryngofissure followed by laryngectomy. One patient had laryngofissure, partial laryngectomy and final laryngectomy, with cure. He died of some other cause three years after the final laryngectomy.

Dr. Buckley seemed very partial to laryngectomy. Certainly, we feel that in any patient in whom laryngofissure is possible it should be done. I hesitate, in the presence of Dr. Jackson, to say anything about laryngofissure because he knows so much more about it than I do, but the method we use in laryngofissure is Dr. Jackson's method. We leave the cartilage in. That permits us to do laryngofissure a second time.

I disagree with Dr. Buckley that the patient should be told that he does not have cancer, that he can forget about it. He should be told that he has it, and he should be seen at least once a month for the first year and every three or four months for the next two or three years. The patient does not worry. He feels that if one cured him the first time one can cure him again if he has a recurrence. He likes to have his larynx. I do not know how Dr. Ludlow feels about having the larynx taken out, but he was very glad when we told him that we thought he could get along with a laryngofissure.

Dr. L. G. Richards, Boston: I should like Dr. Buckley to say a word about laryngofissure plus the insertion of radon seeds. I think the statement has been made that laryngectomy will soon be an operation of the past.

Dr. Chevalier Jackson, Philadelphia: The matter of laryngectomy has been very thoroughly threshed out. I feel that there is nothing more to be said on the subject. There are a few things, however, that I think ought to be mentioned.

Dr. MacKenty's name has been mentioned a number of times in connection with laryngectomy. It was my privilege, and I esteemed it very highly, to see a great many patients in consultation with Dr. MacKenty. I did over one hundred biopsies for him, and we consulted about many of the patients. We never differed as to what should be done about the particular patient. On the floor of the meeting, in discussions, he favored laryngectomy while I favored laryngofissure, but when it came down to the particular patient we never had any difference of opinion. We were always agreed. For example, we saw together a man who had squamous cell carcinoma of the cord, pedunculated—one of those rare cases in which the growth was pedunculated. Dr. Baxter L. Crawford in Philadelphia, Dr. James Ewing in New York and Dr. Francis Carter Wood in New York all went over the specimen, and all agreed that it was squamous cell carcinoma. Dr. MacKenty and I had consultation with Dr. James Alexander Miller, and Dr. MacKenty agreed that in this patient laryngofissure was indicated, and he made just this specification: "When the growth comes back, send the patient to me for the laryngectomy." I agreed. That was fourteen years ago. The patient is now in New York under the care of Dr. Miller. Carcinoma has come back after fourteen years, but it has not come back in the larynx; it has come back in the prostate.

Dr. H. L. Swain, New Haven, Conn.: May I say one word? First to Dr. Ludlow if he is still present. I followed a patient after laryngofissure for thirty years, and the man, a preacher, could fill a whole church with his voice and did so in the last fifteen years of his work. He died of other causes, not so remote as the recurrence that Dr. Jackson referred to.

The second thing I should like to say is that little has been said about the lymphatic glands in the neck in conjunction with the operation. Either I did not hear any comment on these glands or the otolaryngologists do not pay any attention to them nowadays but depend on radiation to take care of that.

Without wishing to bring anything into the discussion of so momentous a paper as this has been I should like to say, and it should be called to the attention of all Americans, that they should be very careful in their selection of fathers. With regard to Dr. Richards and Dr. Jackson, one commends their selection. Last but not least is the selection of a college in which to start life. Dr. Buckley and Dr. Babbitt went to Yale, and I am very proud of that.

Dr. H. H. Forbes, New York: I think every one here will remember the old days when laryngectomy was considered as almost surely fatal.

The points that Dr. Buckley wished to emphasize, I think, are the wonderful exposure he is able to get in removing the hyoid bone (and I have watched his operation and after-treatment) and the marvelous personal care that he gives until the growth is surgically cured.

Dr. R. E. Buckley, New York: I want to answer Dr. Beck for a minute if I may. These very early carcinomas are being treated with roentgen rays, but the time elapsed, as I mentioned in the paper, is still so short that one cannot as yet compare the results with those from laryngofissure. I do not under any circumstances think that irradiation is harmless or that the patient does not mind it. It is far worse than laryngectomy, far more painful to the patient. He goes through a very, very strenuous thirty days. He cannot talk, cannot swallow. All the salivary glands are dried up. Frequently a patient gets necrosis of the thyroid cartilages and edema of the epiglottis and posterior walls of the arytenoid cartilages. In general, it is a very, very strenuous, painful process.

Dr. Tucker, I am afraid I expressed myself poorly if I intimated that I was strongly in favor of laryngectomy. The cases I have observed have been so definitely cases in which the growth could not possibly be treated with laryngofissure that I was forced to choose laryngectomy.

About the patients knowing they have cancer, I did not mean to imply that they should not know it. I meant rather to suggest that one never use that term "cancer." It is poison; it is a stigma; it hurts their feelings. It is the same as telling a man he is syphilitic. One may tell him he is "luetic" but one should not tell him he has syphilis. Tell the patient that he has a tumor that can become malignant or that he has a malignant tumor. Patients do not like the term "cancer."

As to the question of radium and the work in the Memorial Hospital for the treatment of cancer and allied diseases, I prefer high voltage roentgen therapy. Of the patients referred for radium installation, slitting of the larynx and installation of radium, and high voltage irradiation of the larynx, in those whom I have seen, the results from roentgen therapy have been far more satisfactory.

In closing, Mr. President, I should like to say in response to Dr. Swain that he was my professor of laryngology at Yale, and I, too, am proud.

Influence of Residual Pharyngeal Tissue on the Eustachian Tube. Dr. Dunbar Roy, Atlanta, Ga.

This article will be published in full in a later issue of the Archives.

Clinical Significance of Compensatory Granular Pharyngitis. Dr. H. I. Lillie, Rochester, Minn.

This article will be published in full in a later issue of the Archives.

Chronic Infections of the Pharynx: A Pathologic Study. Dr. H. P. Schenck, Philadelphia.

This article will be published in full in a later issue of the Archives.

DISCUSSION

DR. H. L. SWAIN, New Haven, Conn.: A book written in 1846 by Dr. Horace Green beautifully illustrates the condition of granular pharyngitis, or clergyman's sore throat. To review this subject as it has been done here today is very interesting.

The treatment of these conditions is definitely helped by topical application of a 10 per cent solution of silver nitrate.

DR. HORACE NEWHART, Minneapolis: I want to endorse everything that has been said by Dr. Dunbar Roy regarding the importance of careful inspection of the parts not only after operation but before operation. I have observed many cases of recurrence during the last few years. When the recurrence was in a patient of a general practitioner or a less experienced otorhinolaryngologist I thought it might be due to imperfect operation, hurried operation or inexperience, but with cases occurring sometimes in patients of older practitioners, careful operators, I feel that it is a problem to which otolaryngologists should give better attention than they have.

The difficulty of removing recurrent adenoids in children, that is, lymphadenoid tissue, is all that has been said of it. I like the idea of conservatism in the matter of the tube. For purposes of inspection, that is, accessibility, I find that the pharynges of these little children are most easily gone over if one uses an old form of retractor, the origin of which I have quite forgotten, but which involves inserting a rubber tube into each naris, withdrawing it through the mouth and using it as a retractor to draw forward the soft parts so that they are made accessible to inspection with a headlight.

I believe that all the larger masses must be removed surgically rather than by the use of caustics. Young patients are not amenable to this sort of treatment. The nasopharyngoscope does little good because so often one cannot pass it through the naris. Sometimes several operations are required at intervals, three or four of them, I will admit, in those patients in whom adenoids are apt to recur; still in the end one does get results in lessened symptoms, notably in children who have repeated attacks of nasopharyngitis with otitis and tubotympanitis.

If it is not easy to pass the eustachian catheter because of tortuosity of the passage or redundancy or posterior spurs overlooked I am suspicious and hold the patient under consideration and observation. With regard to giving normal patency by resection, the results, while not immediate, are sometimes very striking. The symptoms subside in patients observed over a period of years without any other care or treatment, climatic or otherwise, improvement is obtained in the hearing acuity if the conditions have not gone too long and the patients are not too profoundly deafened.

DR. PERRY GOLDSMITH, Toronto, Canada: A little lymphoid tissue on the lateral wall of the nasopharynx is overemphasized. If a little lymphoid tissue is there and it is irritated by infection, what can it do? It can swell up. That is its protection. If it is taken away there is no protection.

Then there are those who favor removing a large central mass of adenoids. If there are no symptoms of involvement of the ears, leave the rest alone. All know that if there are adhesions to the eustachian tube, the posterior wall, there are no trouble, no symptoms; there are those who like to break them down. They will join up. They do not do any harm. I think repeated removal of adenoids is a detriment to a great many people.

DR. GREGOR MCGREGOR, Toronto, Canada: I have been interested in the mucous glands which occur in all the mucous membranes and which so commonly are hypertrophied when there is infection, whether this infection is in the sinuses, in the nose or in the mucous membrane of the pharynx. Very frequently one sees tremendous hyperplasia of these glands. Commonly, they are enlarged, dilated and show evidence of blockage. Even within these dilated and more or less degenerated or destroyed glands one sees evidence of infection.

Dr. W. B. Chamberlin, Cleveland: Dr. Lillie spoke of the various theories of the function of the tonsil. In these days, when there is such extensive removal of the tonsils and the adenoids, it has often occurred to me that these tremendous hypertrophies which one is wont to call, for instance, pharyngitis lateralis, which appear immediately behind the posterior pillar and in the solitary follicle on the posterior pharyngeal wall may possibly be an answer on the part of nature to the early removal of the lymphoid tissue in Waldeyer's ring.

Dr. Roy spoke of introducing tri-chloro-acetic acid through the rubber catheter. I should hesitate to do that. That is common, an old method, of course, for closing small perforations in the tympanic membrane. I should hesitate to do that for fear of causing stenosis.

Dr. Roy also brought up the very important point that in the rush of hospital and office practice the otolaryngologist relies too much on palpation of the nasopharynx both before and after operation to decide whether all of the adenoid mass has been removed. The suggestion that Dr. Newhart made of inserting a rubber catheter through both nostrils and then retracting the soft palate so that one may examine the nasopharynx visually rather than by palpation might lead to better results in all of these cases.

As far as treatment is concerned, I have found in many cases that if the mass is very large, especially if it is behind the posterior pillar on either side, removing it with the punch forceps is very satisfactory. With hypertrophy of the solitary follicle on the posterior pharyngeal wall the electrocautery has proved immensely beneficial.

Dr. A. P. Voislawsky, New York: I never operate on this tissue. For a number of years I have applied a solution of iodine, Mandl's solution and have had most satisfactory results with it. Mandl's solution is: iodine, 0.3 Gm.; potassium iodide, 0.6 Gm., and glycerin, 1.7 Gm. I never apply silver nitrate in the nasopharynx.

Dr. Dunbar Roy, Atlanta, Ga.: It is hard to use a postnasal mirror in a young child, and it is hard to use a nasopharyngoscope. I do think that whenever it is possible to use either one of those instruments one should use it very thoroughly.

Dr. Chamberlin may have misunderstood me. There were only little particles around the rim and even on the inside; in using that small wire and a deliquescent solution of the tri-chloro-acetic acid one can make a light touch and repeat it in from ten to fifteen days. I have never seen any results from contraction.

I am firmly convinced that in the matter of this lymphoid tissue in Waldeyer's ring not enough attention is paid to the condition before the patient is operated on, that is, to a preliminary treatment before the operation, nor is the postoperative treatment given the attention that it should be given.

I have been using an old-time remedy for years, a preparation containing iodine, bromides and calcium. I give children that before and after operation, and I have seen remarkable clearing up of this tissue even though some of the tissue may have been left. I do think, however, that attention has not been paid to the fact that a certain amount of lymphoid tissue occurs just inside the eustachian tube. Attention is not paid to the eustachian tube possibly because of the more important condition, otosclerosis.

Dr. H. I. Lillie, Rochester, Minn.: In regard to the recurrence of adenoids I think that no matter how assiduously one removes adenoids, how carefully, one will have recurrence in a certain group of patients. It was observation of patients of this type that led me to believe that some other form of treatment must be used in this type. This observation was made on two patients, young patients, in each of whom the adenoid had been removed twice, but following ingestion of syrup of hydriodic acid over a period of six months the adenoid disappeared. One of the patients has now been observed for twelve years, and there has been no recurrence of the pharyngeal symptoms. She takes syrup of hydriodic acid during the winter months.

Dr. Chamberlin brought up the question of compensatory hypertrophy from the standpoint of the function of the tonsillar tissue in the pharynx. I believe it is true that when a large amount of tonsillar tissue has been removed in certain patients there is a tendency on the part of nature to compensate for that great loss by an increase in the size and increase in the amount of the remaining tonsillar tissue. In other words, it is apparent to me that the tonsillar tissue in certain persons has some function which it performs and which the body mechanism needs.

Dr. H. P. Schenck, Philadelphia: In regard to this series of 108 patients with systemic disease and with pharynges that appeared abnormal, a diligent search through the sections failed to reveal involvement of these glands or obstruction of the ducts. I really expected to find such changes but did not.

In the lateral pharyngeal glands, hypertrophic from infection, the major portion of the hypertrophy was due to hyperplasia of the glands rather than to hyperplasia of the lymphoid tissue. This is true of the posterior wall of the pharynx as well, though to a somewhat lesser extent.

Dr. B. R. Shurly, Detroit: There is a tremendous hereditary influence as to what sort of tissue will hypertrophy and develop. One cannot change that any more than one can change blue eyes and brown eyes. There is a family type of lymphoid hypertrophy which is constantly underneath.

There is also the whole problem of immunity. Inflammatory tissue is increased tremendously in those who have low resistance to certain infections. In persons whose resistance is tremendously high, and these suffer seldom from chorea, seldom from suppurative disease of the nose and throat, that irritating influence on the lymphoid tissue is not observed. There is also a dietetic and biochemical equation of lymphoid tissue. Then, again, there is a great psychologic influence that has not been mentioned.

There are in this profession those who think the harm of a pinhead amount of tonsil tissue in the fossa is so great that they keep operating and reoperating. They look in the throat and say, "My goodness, you have a big piece of tonsil left. You may have trouble from that." One does have trouble from it in some but not all patients. There are many patients with enlarged tonsils, with pathologic tonsils, who for years suffer nothing whatever from that condition, though under observation it looks to be a very serious menace. The patient has gotten away with it, as the saying is, and is perfectly well and healthy.

There are deeply hidden scientific truths about the physiologic condition of the lymphoid tissue, and there is an unknown story of just what usefulness some of this tissue has. Until otolaryngologists unravel a few more scientific truths and put these together one does an injustice to both the doctor and to the patient when one condemns the doctor who has not completely removed the tonsil, although one was not there to understand the difficulties, and is destroying instead of constructing a fine psychology among the people.

Fundamentals of the Treatment of Allergic Rhinitis, with Particular Reference to Iontophoresis (Ionization). Dr. L. W. Dean, St. Louis.

The subjects dealt with are the diagnosis of allergic rhinitis, conditions simulating allergic rhinitis and the treatment of allergic rhinitis, especially that by iontophoresis (ionization), with consideration of how iontophoresis acts, the changes it induces in the tissue and the results.

DISCUSSION

Dr. A. W. Proetz, St. Louis: When one is confronted with a patient who has nasal allergy, and the question arises, how can one diagnose this condition, where is one going to get without all of these things that have to be done, the answer is: Simply nowhere. If one is content with scratching skin or making intramucosal tests or changing diets or doing tests for leukopenia or other tests, one is marking time.

I noticed in Dr. Dean's list that skin scratching came about no. 9. I know that many are doing nothing but scratching skins, taking the results of the tests and applying them to noses. As Dr. Dean said, the effects of allergy in any of the tissues are simply the results of some experience in the patient's history, and they are going to crop out now and again. Whether they crop out in the skin or whether they crop out in the bronchi or in the nose may be a matter of accident or may not.

If one is going to study nasal allergy one is going to have to study it in the nose, and one is going to have to study it from one end to the other, eliminating every one of the factors which may singly or in combination precipitate the long chain of symptoms that make one's patients miserable. It looks long and complicated, but I believe there is no other way. I simply emphasize that if one wants to get anywhere one will have to do these things that Dr. Dean talks about.

Dr. H. M. Goodyear, Cincinnati: Dr. Dean brought out that most of these patients show a pale membrane and, I believe, along with the pale membrane usually a rather low blood pressure; at least they tend to do that. The parasympathetic nervous system seems to predominate in them. Perhaps for this reason epinephrine given to asthmatic patients and those with hay fever sometimes brings results through stimulating the sympathetic nervous system. No doubt in these patients there is a change in body chemistry that has not yet been fathomed. Why does a patient suffering from hay fever or from hay fever with asthma get complete relief with dilute hydrochloric acid? I have had many patients who obtained relief with this remedy.

I have had an opportunity to observe a number of patients treated by ionization. I have not used this treatment, as I have felt that if zinc chloride applied to the nose gives a patient relief in allergy one should be able to apply it without the aid of an expensive and rather mysterious-looking machine. I started experimenting with the 1 per cent solution of zinc chloride which is used in ionization and kept trying stronger solutions until now I treat patients in whom I want immediate relief with a solution of 100 per cent zinc chloride (480 grains to 1 ounce of water). In applying it one must use a very small applicator, drawing just a line down the inferior turbinates and placing a little on the septum near the middle turbinate. I had a number of patients last year and several this spring who got relief from this treatment.

Dr. L. W. Dean: I think it wise to keep away from a discussion of the body chemistry and allergy at this time for various reasons. One is that in chemical studies there is always found in the nasal discharge from patients with allergic rhinitis a higher percentage of potassium and calcium than is present in their blood. What mechanism is responsible for the increase in these two substances in the nasal discharge I do not know. Further, if I am not certain whether or not a patient has allergic rhinitis I have the chemist determine the p_H of the nasal discharge. In pure allergic rhinitis, I think the discharge is always alkaline, often up to p_H 8.2. Why is the p_H of this discharge day after day 8.2 when that of the serum in the blood on the other side of the membrane is 7.2? This observation brings in problems. We have worked on the question whether allergen produces a substance in the tissue, and the results will soon be reported by Miss Burmeister. She has found a substance which does not exist in the normal mucous membrane of noses of persons otherwise normal who have died in the hospital recently.

As to the administration of acid, anybody who has worked in allergy for years must admit that now and then a patient is greatly benefited by dilute hydrochloric and nitric acid administered in such dosage that there is no possibility of its having any effect on the chemistry of the body.

In the Department of Medicine at Washington, D. C., and in the service with which I am connected it is realized that one of a great number of persons is benefited by acid, but why this is so is an entirely different question.

I am glad to hear Dr. Goodyear's suggestion about 100 per cent solution of zinc chloride. My co-workers and I want to know of all these drugs. If Dr. Goodyear does not object, we will use that on animals immediately and examine the tissues to see what has happened.

One of the physicians in San Antonio told me that he got as good results from the use of 70 per cent alcohol in the nose as any one could get with ionization, but 70 per cent alcohol killed all our cats. After being treated with it every one of them died of snuffles.

STAPHYLOCOCCUS IN RELATION TO SINUSITIS, BRONCHITIS AND BRONCHIECTASIS. DR. F. D. WOODWARD, University, Va.

This article will be published in full in a later issue of the ARCHIVES.

DISCUSSION

DR. E. C. SEWALL, San Francisco: I think the tendency to simplify the classification of bacteria is very important. Classification of Staphylococcus under its hemolytic properties agrees very largely with that of Streptococcus. I have felt that Streptococcus is the cause of conditions such as those which Dr. Woodward has described. I believe that Streptococcus causes the trouble initially and that Staphylococcus is a secondary invader.

ENDOCRINE IMBALANCE AND ITS RELATION TO THE UPPER RESPIRATORY TRACT. DR. G. F. HARKNESS, Davenport, Ia.

The paper gives in résumé the interrelationship between the endocrine glands. The importance of the age incidence in the symptomatology is brought out. Endocrine incretions are recognized as principles, but little is known of them as chemical entities or of how they affect the body metabolism. Variations in the appearances of the upper respiratory mucous membranes are often ascribed to some metabolic disturbance that may also be present. This may lead to false conclusions. An attempt is made in this paper to review cases of frank endocrine imbalance and through examination of the upper respiratory tract to classify the abnormal conditions present.

DISCUSSION

DR. B. R. SHURLY, Detroit: The relationship of hyperthyroidism to pathologic changes in Waldeyer's ring is often very definite, and the use of compound solution of iodine and thyroid extract has extreme value in certain cases if one can properly classify them.

The value of thyroid extract for patients with myxedema is well understood and perfectly defined, and yet even when one is able to detect those patients they should be referred to the department of internal medicine and pediatrics as well and given proper observation.

This subject is so highly specialized in its observations and understanding that those of the otolaryngologic specialty do not know very much about it, but in the school system here the clinic for patients with glandular conditions, in which many thousands of children have been taken care of, has proved that the imbalance arising from thyroid and pituitary disease among these children is well worth adjustment, and that the intelligence quotient of some is raised remarkably under proper observation and medication. The glandular constitution is very closely related with tonsils and adenoids and the developmental story of the child.

(To be Concluded)

News and Comment

THE AMERICAN BOARD OF OTOLARYNGOLOGY

An examination was held in Kansas City, Mo., on May 9, 1936, during the meeting of the American Medical Association. Forty-three candidates were examined, of whom thirty-four were passed and nine were conditioned or failed.

Hereafter examination will be of two days' duration and will include written as well as oral tests. After Jan. 1, 1938, no certificate will be granted "formally," that is, without examination, and the examination in pathology must be taken by all candidates.

An examination will be held in New York City on Sept. 25 and 26, 1936, just prior to the meeting of the American Academy of Ophthalmology and Otolaryngology. Application blanks may be procured from the secretary, Dr. W. P. Wherry, 1500 Medical Arts Building, Omaha, Neb.

Book Reviews

Eye, Ear, Nose and Throat Manual for Nurses. By Roy H. Parkinson, M.D., St. Joseph's Hospital, San Francisco. Third edition. Price, $2.25. Pp. 232, with 72 illustrations. St. Louis: C. V. Mosby Company, 1936.

The illustrations include anatomic diagrams, pictures of the common instruments used in examination of and operations on the eye, ear, nose and throat and figures portraying methods of treatment. A brief account is given of all the commoner conditions met with in the fields of otolaryngology and ophthalmology, with a consideration of the usual treatment. A more detailed account is given of the preoperative and postoperative care of patients on whom the principal operations on the eye, ear, nose and throat are performed. For nurses particularly engaged in the care of patients with disorders of the eye, ear, nose or throat this should be a valuable manual for instruction and reference. It is probably too detailed for use in the general training of nurses.

Directory of Otolaryngologic Societies *

FOREIGN

Collegium Oto-Rhino-Laryngologicum Amicitiæ Sacrum

President: Prof. Gunnar Holmgren, Karolinska Mediko-Kirurgiska Institutet, Stockholm, Sweden.
Secretary: Prof. Dr. C. E. Benjamins, Verlengde Heereweg, 143 Groningen, The Netherlands.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. Robert F. Ridpath, 1737 Chestnut St., Philadelphia.
Secretary: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
Place: Atlantic City, N. J. Time: June 7-11, 1937.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
President-Elect: Dr. Frank E. Burch, 408 Peter St., St. Paul.
Executive Secretary: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: New York. Time: Sept. 26-Oct. 3, 1936.

American Bronchoscopic Society

President: Dr. Joseph C. Beck, 185 N. Wabash Ave., Chicago.
Secretary: Dr. Lyman Richards, 319 Longwood Ave., Boston.

American Laryngological Association

President: Dr. W. B. Chamberlain, 10515 Carnegie Ave., Cleveland.
Secretary: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. George M. Coates, 1721 Pine St., Philadelphia.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester, N. Y.

SECTIONS:

Eastern.—Chairman: Dr. D. C. Jarvis, Quarry Bank Bldg., Barre, Vt.
Southern.—Chairman: Dr. Charles D. Blassingame, P. & S. Bldg., Memphis, Tenn.
Middle.—Chairman: Dr. Alfred Lewy, 25 E. Washington St., Chicago.
Mid-Western: Dr. Frederick A. Figi, 1013 First St., S.W., Rochester, Minn.
Western.—Chairman: Dr. David R. Higbee, 3245 Fourth St., San Diego, Calif.

American Otological Society

President: Dr. Edmund Prince Fowler, 140 E. 54th St., New York.
Secretary: Dr. Thomas J. Harris, 104 E. 40th St., New York.

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* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.